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Tumbuhan air sebagai niche (bertelur dan memelihara anak) ikan air tawar pada habitat rawa di Kalimantan Selatan Indonesia

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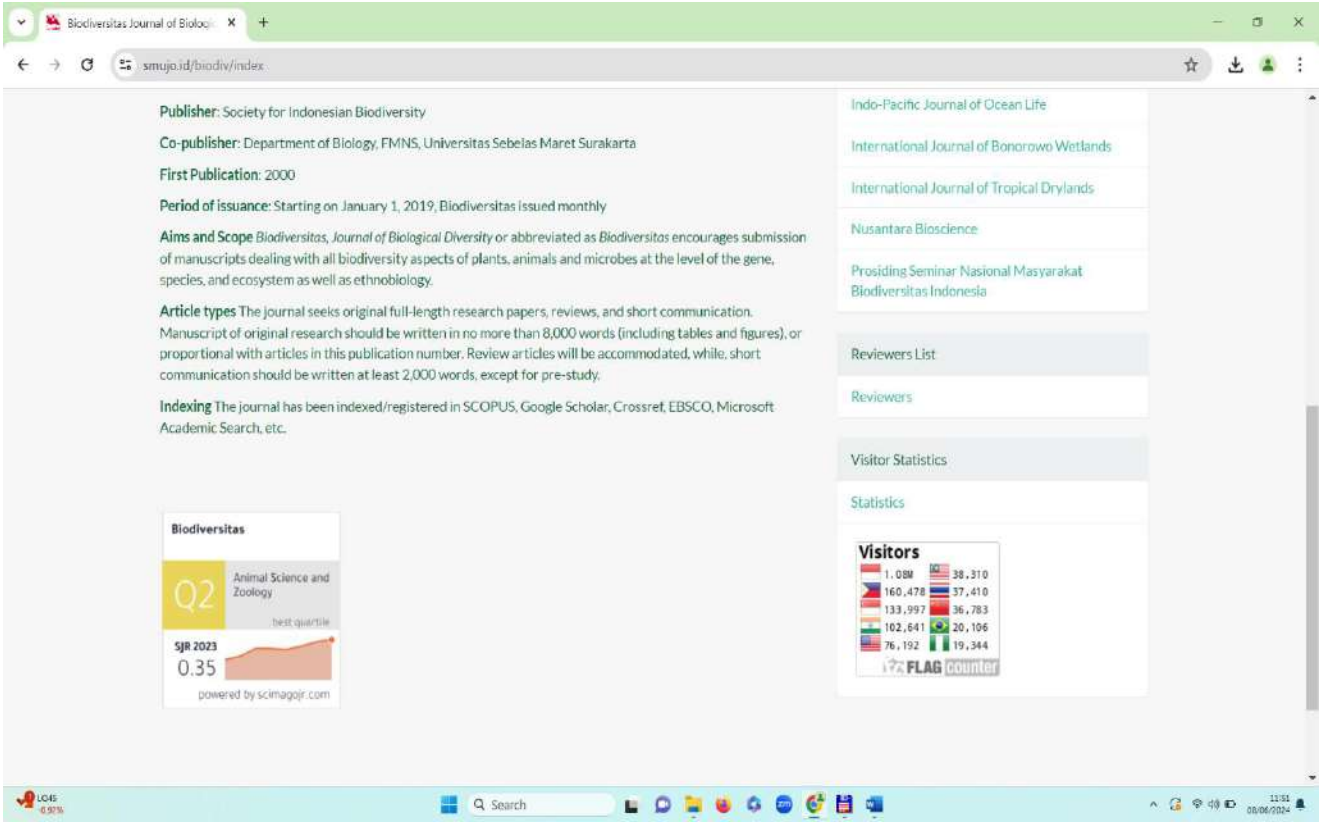

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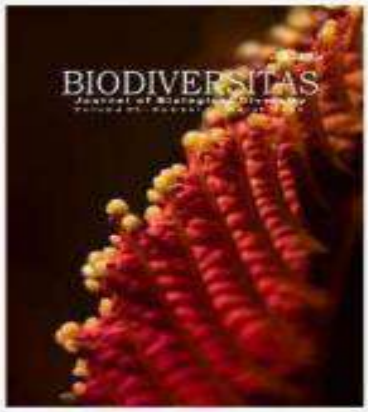

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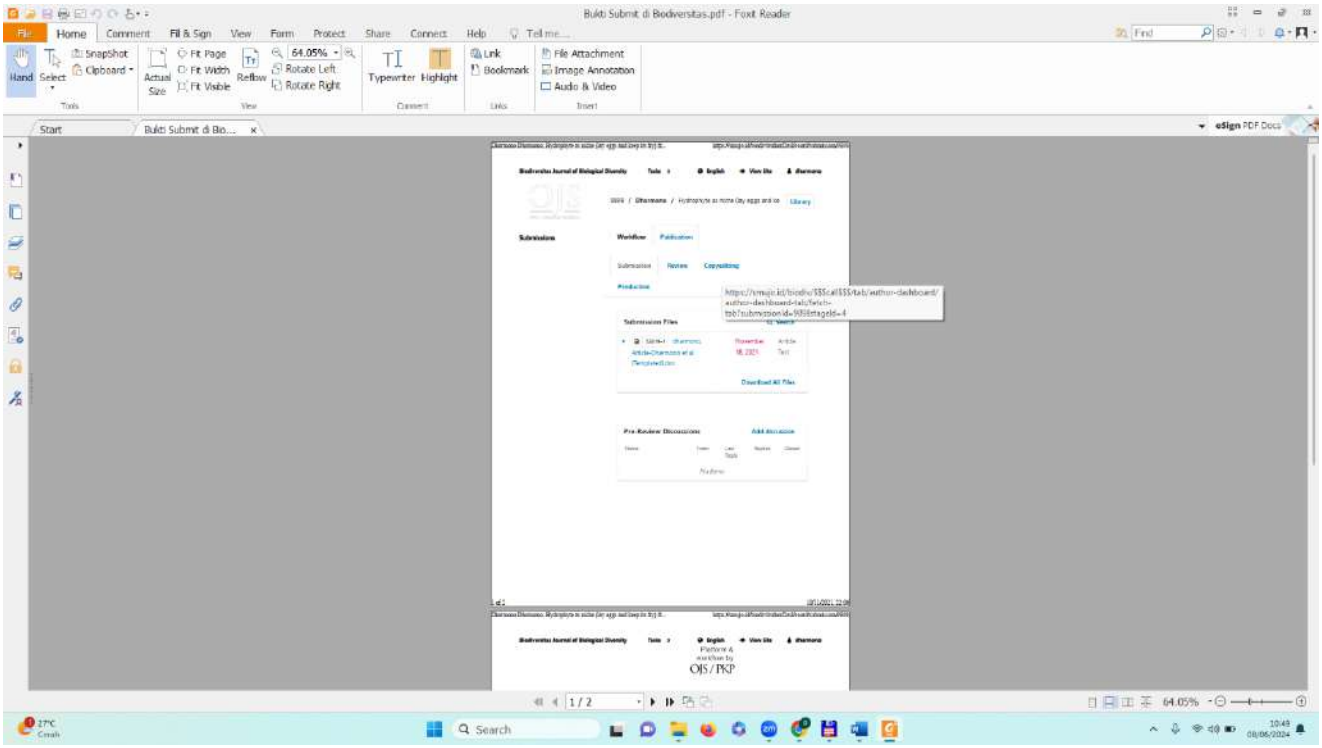

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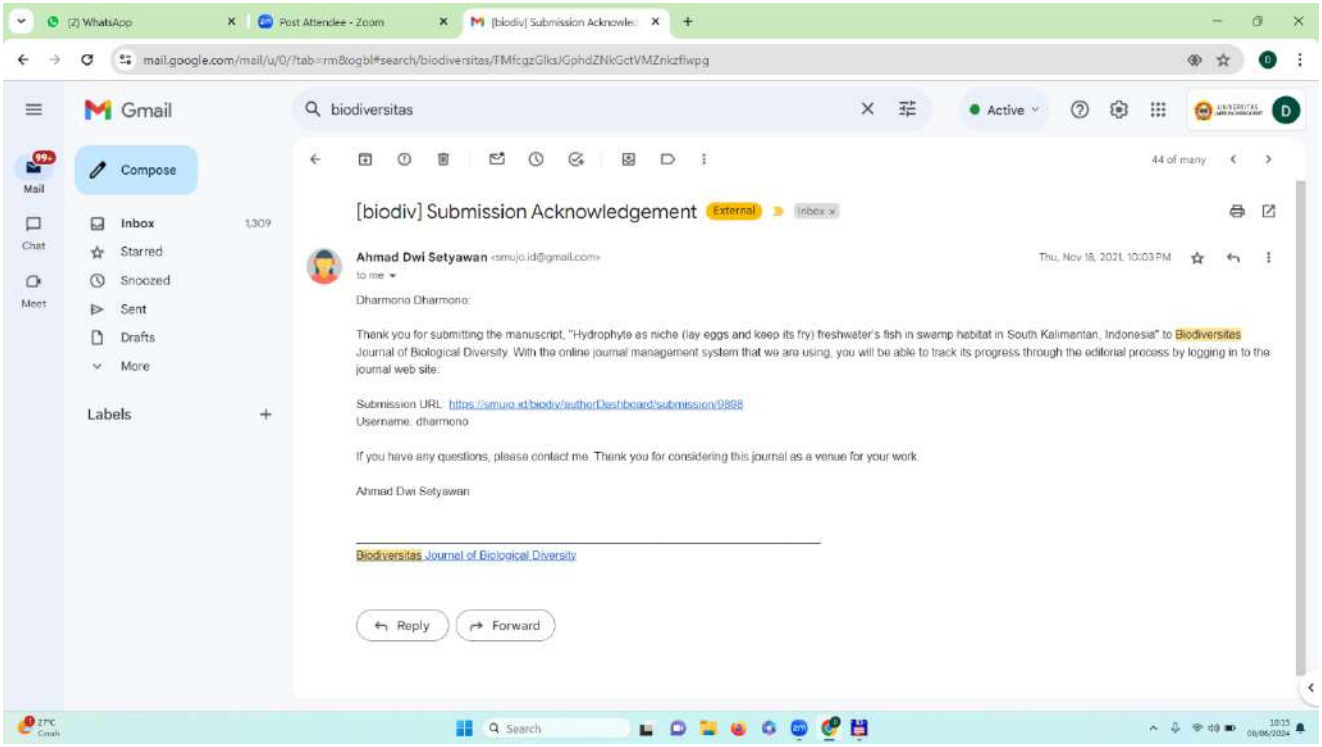

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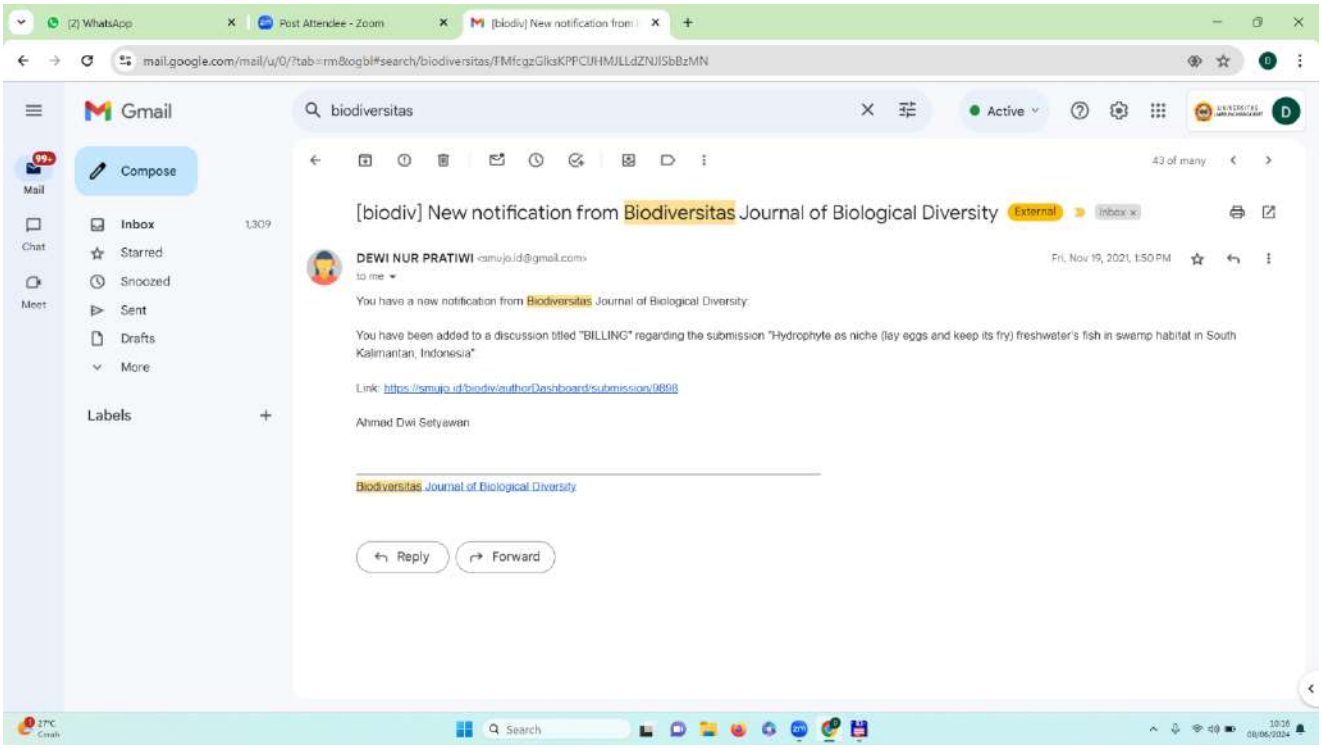

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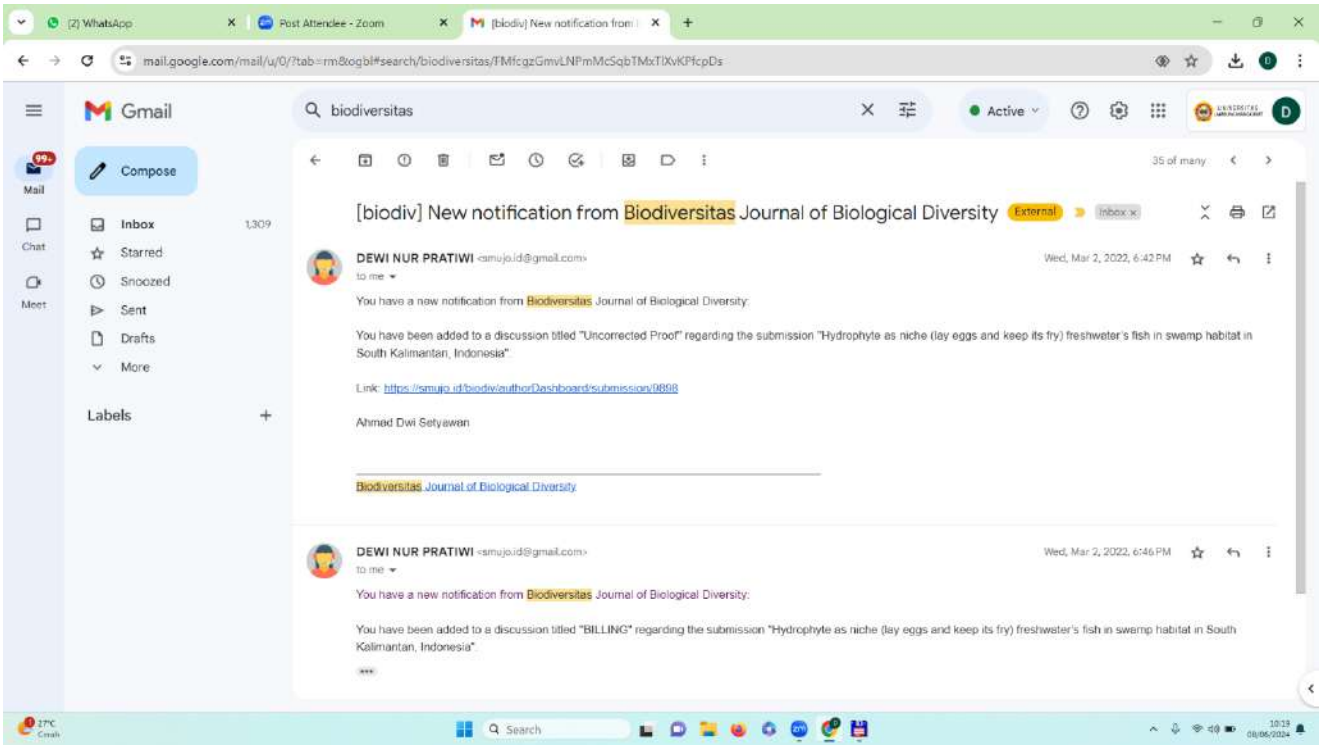

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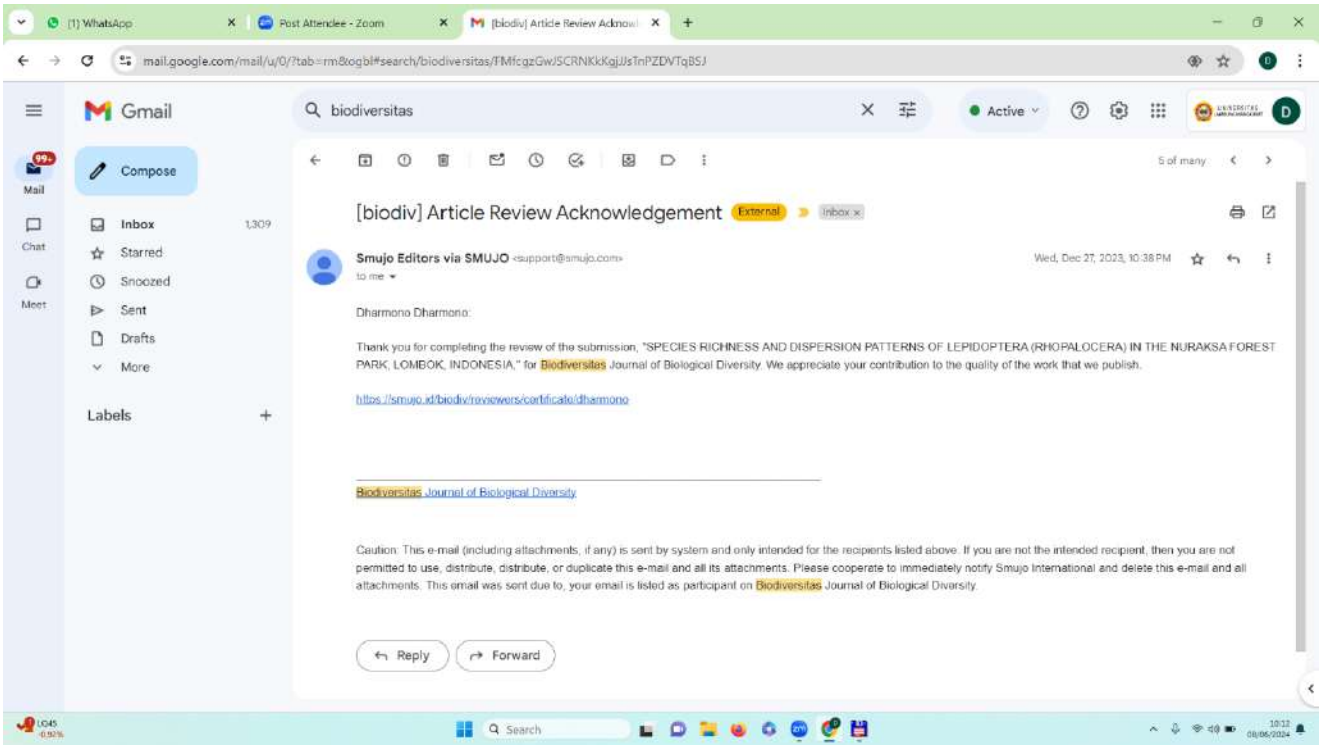

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Explorasi tumbuhan air sebagai niche ikan air tawar pada habitat rawa di Kalimantan Selatan, Indonesia

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Abstract. Sekitar 208.893 ha dari total luas wilayah Kalimantan Selatan merupakan rawa. Vegetasi rawa hidup bersimbiosis dengan hewan di sekitarnya. Kami menemukan banyak penelitian yang meneliti keduanya secara terpisah, tetapi interaksi spesifik antara spesies hewan air dan tumbuhan rawa jarang diamati di sini. Hewan air seperti ikan sangat bergantung terhadap keberadaan tumbuhan yang hidup di rawa sebagai *Niche* atau mikrohabitat khususnya untuk berlindung dan berkembang biak. Tujuan penelitian ini adalah untuk mengeksplorasi tumbuhan rawa yang dimanfaatkan sebagai Niche ikan air tawar untuk bertelur dan memelihara anak. Metode penelitian yang digunakan adalah penelitian deskriptif kwantitatif. Populasi penelitian adalah semua tumbuhan yang ditemukan di tiga habitat rawa Kalimantan Selatan Indonesia, yaitu Rawa Kabupaten Hulu Sungai Utara, Rawa Kabupaten Tanah Laut, dan Rawa Kabupaten Barito Kuala. Sampel penelitian ditetapkan secara Purposive Random Sampling pada setiap rawa terhadap jenis-jenis tumbuhan yang ditemukan telur dan anakan ikan. Data penelitian dianalisa secara diskriptif dengan menggunakan pustaka. Hasil penelitian ditemukan 26 spesies tumbuhan yang digunakan oleh 17 spesies ikan rawa untuk bertelur dan membesarkan anak.

Keywords: Tumbuhan rawa, tempat berpijah dan memelihara anak ikan

INTRODUCTION

Rawa merupakan ekosistem yang tergenang air, asam, anoksik, dan oligotrofik (Too et al., 2021). Rawa berdistribusi pada ekosistem sebagai daerah dataran banjir (Phiri et al., 2021), bank benih (Lei & Middleton, 2021), transisi air antara daratan dan atmosfer (Ohkubo et al., 2021), dan di laboratorium sebagai media untuk budidaya organisme dan studi kinetik (Padil et al., 2021). Dalam satu dekade terakhir, ekosistem rawa mengalami banyak fenomena seperti kebakaran hutan yang lebih sering terjadi pada musim kemarau (Kubik et al., 2020), perubahan lingkungan dan iklim (Lei & Middleton, 2021) yang mempengaruhi siklus karbon (Liu et al., 2020), dan populasi hewan rawa semakin berkurang karena berkurangnya relung (Paul et al., 2020).

Rawa terbesar di Kalimantan Selatan adalah rawa lebak, baik secara musiman maupun permanen. Luas lahan rawa lebak di Kalimantan Selatan sekitar 208.893 ha dengan vegetasi yang didominasi oleh tumbuhan perdu dan perdu. Vegetasi hutan rawa mampu beradaptasi dengan daerah yang anaerobik dan tergenang secara musiman atau permanen. Whetstone (2009) menyatakan vegetasi tumbuhan rawa berdasarkan keberadaannya di air dikelompokkan menjadi tiga kelompok yaitu tumbuhan permukaan, tumbuhan terapung dan tumbuhan terendam. Tumbuhan permukaan memiliki akar di dasar air dengan daun memanjang ke atas hingga ke permukaan air, misalnya *Saggittaria sinensis* dan *Phragmites communis*. Sementara itu, Goel (2006) menyatakan bahwa tumbuhan terapung adalah tumbuhan yang akarnya menggantung di air atau tidak menyentuh dasar air, misalnya *Nymphaea* sp. dan *Nelumbo* sp. Tumbuhan terendam adalah tumbuhan yang hidup sepenuhnya di air, misalnya *Hydrilla verticillate*, *Najas minor*, *Chara vulgaris*, dan *Ceratophyllum demersum*. Hasil penelitian yang dilakukan oleh Djufri dkk. (2016) menemukan 41 jenis tumbuhan herba di hutan rawa gambut Tripa, Indonesia.

Ekosistem rawa gambut merupakan salah satu kawasan penting dan merupakan habitat yang memiliki endemisme spesies yang tinggi (Joni et al., 2015). Vegetasi yang berbeda dalam zonasi ekosistem ini menunjukkan pembentukan relung. Namun, ada variasi spasial skala kecil yang menunjukkan sifat stokastik vegetasi (DiMichele et al., 2017). Vegetasi berbuah pahit dan berbuah manis juga dapat membentuk relung ekologi yang berbeda (Vihotogbé et al., 2019). Area niche dan keragaman trofik dapat menunjukkan penggunaan sumber daya sesuai dengan ketersediaan trofik, terlepas dari ukuran atau jenis kelamin (Correia, 2002). Rawa ridge-hollow dapat menghasilkan kerangka relung ekologi dalam media berair asam kuat (Rybina et al., 2014), yang dapat digunakan sebagai prediksi tentang apa tanaman air dan hewan air dapat hidup di daerah tersebut. Ndehedehe et al., (2020) menyatakan pengelolaan habitat perairan dapat mendukung terpeliharanya keanekaragaman hayati perairan. Menurut Kłosowski & Jabłońska (2009), selain variabilitas yang luas, kondisi habitat di badan air dibedakan berdasarkan dominasi spesies tumbuhan air yang berasosiasi dengan habitat tertentu.

Tumbuhan air di habitat vegetasi rawa berperan penting bagi kehidupan ikan (Kurniawan & Paramita, 2019). Hewan air seperti ikan sangat bergantung pada keberadaan tumbuhan yang hidup di rawa-rawa sebagai relung atau habitat mikro, terutama untuk tempat berteduh dan berkembang biak (Raharjo, 2018). Kelimpahan tumbuhan air berkorelasi positif dengan populasi ikan. Habitat dengan tanaman air dalam jumlah sedang menyediakan lingkungan yang optimal bagi banyak

ikan untuk meningkatkan keanekaragaman, makan, pertumbuhan, dan reproduksi ikan. Sebaliknya, vegetasi yang terbatas dan berlebihan dapat menurunkan laju pertumbuhan ikan pada 75% hingga 85% dari cakupan komunitas tumbuhan (Ismail et al., 2018). Tumbuhan air dimanfaatkan ikan untuk bertelur di permukaan daun tumbuhan air atau di antara tumbuhan berdaun halus pada vegetasi mangrove (Triyanto et al., 2019). Contohnya, induk ikan Chlaria batracus dan Ikan Melanotaenia sp. biasanya membentuk pasangan, bertelur, dan melindungi telur dan biji dari bahaya di bawah tanaman air (Lende & Khileri, 2021). …

Setiap jenis tumbuhan memiliki ciri morfologi yang spesifik untuk beradaptasi dengan habitatnya (Steenis, 2013). Karakteristik morfologi tersebut diduga dimanfaatkan oleh spesies ikan air tawar sebagai habitat hidup dan tumbuh. Berdasarkan hasil penelitian Ismail et al. (2018) dan jurnal ilmiah lainnya, belum ditemukan hasil penelitian yang melaporkan jenis tumbuhan tertentu yang dipilih oleh jenis ikan tertentu sebagai tempat bertelur dan membesarkan anak-anaknya. Selain kontribusi dalam bentuk penelitian, jenis tumbuhan yang disukai ikan perlu dipertahankan dan ditingkatkan kesuburannya. Ini bertujuan untuk menjamin perkembangbiakan ikan air tawar. Kontribusi ini perlu disebarluaskan kepada masyarakat yang tinggal di sekitar rawa melalui pendidikan atau penyuluhan tentang potensi, ancaman, dan konservasi lahan rawa, khususnya keberadaan tumbuhan air terhadap keberadaan ikan air tawar di habitat rawa, bahkan sengaja ditanam agar semakin banyak ikan. Oleh karena itu, penelitian ini bertujuan untuk mengeksplorasi jenis tumbuhan rawa yang dipilih oleh ikan air tawar sebagai relung dalam bertelur dan memelihara benihnya.

MATERIALS AND METHODS

Penelitian ini dilaksanakan di tiga habitat rawa Kalimantan Selatan Indonesia, Rawa Kabupaten Hulu Sungai Selatan, Rawa Kabupaten Tanah Laut, dan Kabupaten Barito Kuala pada bulan April 2021. Jenis penelitian yang digunakan adalah penelitian deskriptif observatif. Luas rawa pengamatan di Rawa Kabupaten Hulu Sungai Utara adalah 92,5 Ha, Rawa Kabupaten Tanah Laut adalah 56,7 Ha, dan Rawa Kabupaten Barito Kuala adalah 47,2 Ha (Gambar 1). Sampel penelitian ditetapkan secara Purposive Random Sampling pada setiap rawa dengan mengamati dan mendokumenkan jenis-jenis tumbuhan yang ditemukan telur dan anakan ikan sebagai data *Niche* ikan rawa untuk bertelur dan membesarkan anak. Penentuan telur dan anakan ikan didasarkan atas kehadiran induk ikan di sekitar telur dan anakan ikan tersebut. Data penelitian dianalisa secara diskriptif dengan menggunakan pustaka untuk mengidentifikasi spesies tumbuhan air dan spesises ikan air tawar.

Gambar 1. Lokasi Penelitian

RESULTS AND DISCUSSION

Berdasarkan hasil penelitian terhadap tumbuhan rawa yang berpotensi sebagai *Niche* ikan rawa di tiga kawasan rawa Kalimantan Indonesia, ditemukan 26 spesies tumbuhan air yang digunakan oleh 17 spesies ikan rawa untuk bertelur dan membesarkan anak seperti yang ditampilkan pada Tabel 1. Hasil penelitian ini lebih banyak ditemukan tumbuhan air yang digunakan sebagai niche ikan daripada penelitian yang dilakukan oleh Ismail, *et.al*. (2018) yang menemukan 8 spesies tumbuhan, yaitu; *Lemna minor, Polygonum barbatum, Eichhornia crassipes, Pistia stratiotes, Neptunia oleracea, Hydrilla verticillata, Salvinia molesta, Phragmites australis, dan Azolla pinnata.* Akan tetapi hasil penelitian tersebut tidak menjelaskan khusus tumbuhan apa saja yang paling disukai oleh spesies-spesies ikan air tawar.

Tabel 1. Tumbuhan Rawa yang Berpotensi Sebagai Niche Ikan Rawa

No.	Spesies Tumbuhan	Spesies Ikan																
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**
1	*Azolla pinnata*		A													A	A	
2	*Caladium* sp.		A							A						A		A
3	*Cyperus digitatus*		T	T	A	T				A			A			A	A	A
4	*Diplazium esculentum*	A	T	T				A						A		A		A
5	*Phaspalum conjugatum*	A		T	A	T		A		A				A			A	
6	*Eichornia crassipes*	A	T	T	A	A	T	A	A	A	T	A	A	A	A	A	A	T
7	*Hydrilla verticillata*														A			
8	*Hydrocharis Morsus*	A						A						A		A		A
9	*Hymenachne amplexicaulis*	A	T	T		T		A						A		A		T
10	*Ipomoea aquatica*		T	A	A				A	A		A			T		A	
11	*Lemna Minor*		T	T	A	T					T	A			A	A		T
12	*Lemna perpusilla*														A	A		T
13	*Limnocharis flava*	A						A						A		A	A	A
14	*Megathyrsus maximus*				A	A				A								
15	*Nelumbo nucifera*		A	T	A	T	T					A				A	A	A
16	*Neptunia oleracea*			A			A		A							A		T
17	*Nymphaea alba*		A	T	A						A		T		A	A		T
18	*Nymphaea lotus* L.															A		T
19	*Pistia stratoites*	A	T	A	A	T		A	A			A		A		A	A	A
20	*Salvinia minima*		T	A					A							A		A
21	*Salvinia molesta*									A		A			T	A	A	T
22	*Salvinia natans*		T	T		T			A	A						A	A	T
23	*Stenochlaena palustris*	A						A		A			A	A		A	A	A
24	*Utricularia aurea*	A	T	T	A	T		A						A		A		A
25	*Zoysia matrella*	A		A				A	A					A		A		T
26	*Crinum asiaticum*		T		A				A			A	A	A	T		A	T

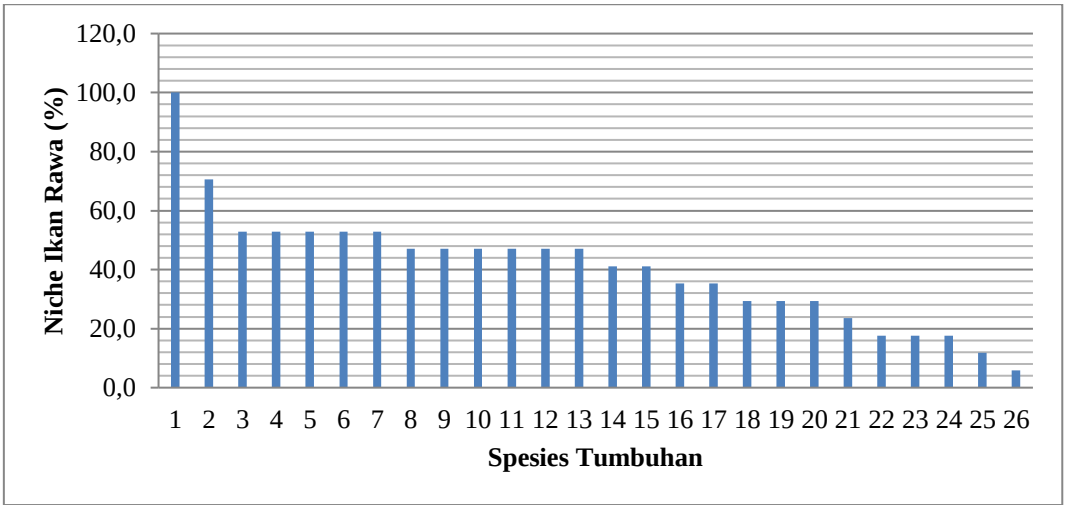
Keterangan : T = Telur, A = Anakan

A	*Channa striata*	G	*Channa micropeltes*	M	*Channa lucius*
B	*Anabas testudineus*	H	*Cyprinus carpio*	N	*Rasbora argyrotaenia*
C	*Trichogaster trichopterus*	I	*Pampus argenteus*	O	*Mystus Scopoli*
D	*Rasbora dusonensis*	J	*Clarias batrachus*	P	*Osteochilus hasselti*
E	*Trichogaster pectoralis*	K	*Criptopterus spp*	Q	*Oxyeleotris marmorata*
F	*Helestoma temminkii*	L	*Hemibagrus nemurus*		

Berdasarkan penelitian yang dilakukan pada bulan April 2021 terlihat, bahwa keberadaan ikan pada tumbuhan rawa ada 2 bentuk yaitu masih berbentuk telur yang ditunjukkan keberadaan buih di sekitar tumbuhan dan berupa anakan (Tabel 1 dan Gambar 2). Hal tersebut menunjukkan, bahwa masa reproduksi ikan air tawar berbeda-beda atau tidak bersamaan. Seperti yang dilaporkan oleh Setyaningrum dan Wibowo (2017), kemampuan reproduksi pada 5 species ikan (*Cyprinus carpio, Barbonymus gonionatus, Osteochillus vittatus, Oreochromis niloticus* dan *Clarias gariepinus*) menunjukkan perbedaan. Seperti yang dijelaskan Devkota & Kathayat (2020), bahwa perubahan iklim sangat mempengaruhi reproduksi, perkembangan, struktur, dan kelimpahan populasi ikan air tawar. Selain itu potensi reproduksi ikan tergantung pada perkembangan gonad sampai ikan memijah dan menghasilkan benih. Berdasarkan informasi masyarakat yang tinggal di ketiga kawasan rawa yang diteliti, musim kawin bagi ikan di daerah tersebut yang ditunjukkan oleh adanya telur dan anakan ikan adalah pada bulan Februari sampai Agustus.

Gambar 2. Keterdapatan telur dan anakan ikan haruan pada tumbuhan air

Berdasarkan Gambar 3 terlihat, bahwa tumbuhan air yang dominan atau paling banyak dimanfaatkan oleh ikan yang hidup di rawa sebagai *Niche* bertelur dan pemeliharaan anak adalah *Eichornia crassipes* sebesar 100% semua spesies ikan air tawar yang ditemukan (17 spesies ikan), kemudian disusul oleh *Pistia stratoites* sebesar 70,6% (12 spesies ikan), *Cyperus digitatus* 52,9% (9 spesies ikan), *Lemna minor* 52,9% (9 spesies ikan), *Nelumbo nucifera* 52,9% (9 spesies ikan), *Utricularia aurea* 52,9% (9 spesies ikan), *Crinum asiaticum* 52,9% (9 spesies ikan), *Diplazium esculentum* 47,1% (7 spesies ikan), *Hymenachne amplexicaulis* 47,1% (8 spesies ikan), *Ipomoea aquatica* 47,1% (8 spesies ikan), *Nymphaea alba* 47,1% (8 spesies ikan), *Salvinia natans* 47,1% (8 spesies ikan), *Stenochlaena palustris* 47,1% (8 spesies ikan), *Phaspalum conjugatum* 47,1% (8 spesies ikan), *Bulbostylis juncoides* 41,2% (7 spesies ikan), *Limnocharis flava* 35,6% (6 spesies ikan), *Salvinia molesta* 35,3% (6 spesies ikan), *Hydrocharis Morsus* 29,4% (5 spesies ikan), *Neptunia oleracea* 29,4% (5 ikan), *Salvinia minima* 29,4% (5 ikan), *Caladium sp*. 23,5% (4 ikan), *Azolla pinnata* 17,6% (3 spesies ikan), *Lemna perpusilla* 17,6% (3 spesies ikan), *Bulbostylis barbata* 17,6% (3 spesies ikan), *Nymphaea lotus* 11,8% (2 spesies ikan). Sedangkan tumbuhan yang paling sedikit dimanfaatkan oleh ikan untuk bertelur dan membesarkan anak adalah tumbuhan *Hydrilla verticillata* yaitu sebesar 5.9% (1 spesies ikan). Hal tersebut menunjukkan, bahwa spesies tumbuhan rawa menentukan jenis-jenis ikan air tawar untuk bertelur dan memelihara anak.



Keterangan :

1. *Eichornia crassipes*
2. *Pistia stratoites*
3. *Cyperus digitatus*
4. *Lemna minor*
5. *Nelumbo nucifera*
6. *Utricularia aurea*
7. *Crinum asiaticum*
8. *Diplazium esculentum*
9. *Hymenachne amplexicaulis*
10. *Ipomoea aquatica*
11. *Nymphaea alba*
12. *Salvinia natans*
13. *Stenochlaena palustris*
14. *Phaspalum conjugatum*
15. *Bulbostylis barbata*
16. *Limnocharis flava*
17. *Salvinia molesta*
18. *Hydrocharis Morsus*
19. *Neptunia oleracea*
20. *Salvinia minima*
21. *Caladium sp.*
22. *Azolla pinnata*
23. *Lemna perpusilla*
24. *Bulbostylis juncoides*
25. *Nymphaea lotus* L
26. *Hydrilla verticillata*

Gambar 3. Tumbuhan Rawa yang Berpotensi Sebagai Niche Ikan Rawa (%)

Berdasarkan hasil penelitian, ciri morfologi tumbuhan air yang dimanfaatkan ikan sebagai relung untuk bertelur dan membesarkan anak adalah ciri morfologi daun dan akar tumbuhan tersebut. Jenis tumbuhan *Eichornia crassipes* merupakan tumbuhan air dengan relung terluas untuk berbagai jenis ikan rawa. Sebagai gambaran, berikut disajikan bagaimana ciri-ciri tumbuhan *Eichornia crassipes* sebagai tumbuhan yang paling disukai ikan untuk bertelur dan beternak

ikan muda. *Eichornia crassipes* adalah tumbuhan berhabitus herba makrofit atau tumbuhan yang sepanjang hidupnya mengapung di atas air. Tumbuhan ini memiliki helai daun yang tersusun dalam bentuk roset, berbentuk bulat telur lebar yang sangat menguntungkan ikan untuk menempelkan telur bagi ikan yang meletakkan telurnya pada permukaan datar. Selain itu helaian daun yang lebar akan melindungi telur dan anak ikan dari efek sinar matahari langsung. Sistem perakaran eceng gondok adalah serabut dengan banyak akar-akar kecil yang subur dan lebat akan menjadi tempat yang sesuai bagi ikan yang peletakan telurnya diantara akar-akar kecil tersebut. Selain itu akar-akar kecil yang subur dan lebat banyak ditemukan bahan-bahan organik dan anorganik yang dibutuhkan sebagai sumber makanan bagi anak ikan. Warna akar yang hitam akan melindungi telur dan anak-anak ikan dari bahaya predator. Karakteristik morfologi yang seperti itulah yang menyebabkan tumbuhan ini paling disukai oleh ikan air tawar untuk bertelur dan memelihara anaknya. Dalam penelitian ini semua ikan yang ditemukan sebanyak 17 spesies air tawar yang hidup di rawa bertelur, dan memelihara anaknya pada *Eichornia crassipes.* Hasil penelitian lain yang juga menemukan *Eichornia crassipes* sebagai niche ikan untuk melakukan reproduksi dilakukan oleh Whetstone (2009), Gettys (2009) dan Ismail, *et.al.* (2018).

Pistia stratoites memiliki daun memiliki macam daun tunggal. dengan tata letak daun roset akar yang lebat dan rapat, bentuk daun bangun sudip, tepi daun berlekuk, dengan permukaan daun halus bergaris-garis berambut, testur daun tebal dan lembut dengan panjang 1,3-10 cm dengan lebar 1,5-6 cm. Morfologi daun yang demikian sangat menguntungkan ikan untuk menempelkan atau meletakkan telur. Selain itu helaian daun yang berkumpul atau roset akan melindungi telur dan anak ikan dari efek sinar matahari maupun arus atau gelombang air. Akar tumbuhan ini masuk di dalam dasar air, sehingga tidak dapat dimanfaatkan oleh ikan untuk menempelkan atau meletakkan telur. Sementara itu pada *Hydrilla verticillate* hanya ditemukan ikan *Rasbora argyrotaenia* yang menggunakan tumbuhan tersebut sebagai tempat bertelur dan membesarkan anaknya. *Hydrilla verti*cillata merupakan berhabitus herba yang hidup di air menjalar rapat, dengan batang memiliki interkalar 0,7 cm-1,4 cm bercabang yang terdapat daun tunggal, dengan tata letak dalam lingkaran yang berjumlah 3-6 daun yang berbentuk daun lanset, tepi daun bergerigi, permukaan daun dengan panjang 0.6-2,5 cm dan lebar 1,2-5,5 cm. Sistem perakaran tumbuhan ini adalah serabut menancap di dasar air. Berdasarkan karakteristik morfologi tersebut, maka potensi tumbuhan sebagai niche untuk bertelur dan membesarkan anak hanya pada daun. Selain itu dengan habitusnya yang rapat, akan menjadi hambatan bagi ikan-ikan berukuran menengah dan besar untuk keperluan reproduksi tersebut. Sehingga hanya ikan yang berukuran kecil yang dapat memanfaatkan tumbuhan tersebut untuk bertelur, dan membesarkan anak yang dalam penelitian ini adalah *Rasbora argyrotaenia.* Hasil penelitian lain yang juga menemukan *Hydrilla verticillate* sebagai niche ikan dilaporkan oleh Ismail, *et.al*. (2018).

Berdasarkan uraian di atas, maka ciri morfologi bentuk, ukuran, jumlah dan daun yang mengapung dipermukaan, bentuk dan jumlah serabut akar yang mengapung di air paling banyak digunakan oleh ikan air tawar untuk bertelur dan memelihara benihnya. Semakin besar ukuran daun dan jumlah daun yang menutupi permukaan air, semakin kasar permukaan dan tepi daun, semakin rapat sistem akar serabut tumbuhan di dalam air (bukan di dalam tanah), semakin banyak ikan memilih tumbuhan tersebut untuk bertelur dan membesarkan anak. Selain itu, morfologi daun yang lebar dan melimpah akan memperlambat aliran air oleh arus, perairan di sekitarnya menjadi tenang, sehingga efektif untuk bertelur dan beternak ikan. Rimpang dan akar yang padat di dalam air dapat menahan dan mengikat mineral dan bahan organik yang dibutuhkan oleh ikan muda untuk tumbuh. Tumbuhan air yang berdaun lebar di dalam atau dipermukaan air memiliki peran penting sebagai oksidator di dalam air, sehingga sangat efisien dalam mengikat karbondioksida di dalam air dan melepaskannya menjadi oksigen yang bermanfaat bagi ikan muda. Konsep gulma di habitat rawa bila dilihat dari sudut pandang pentingnya menjaga keanekaragaman ikan sebaiknya tidak digunakan, karena habitat rawa bukan merupakan kawasan yang digunakan untuk budidaya tanaman produktif. Keberadaan tumbuhan air di habitat rawa perlu dijaga agar ikan air tawar yang dibutuhkan oleh masyarakat yang tinggal di daerah tersebut dapat selalu terjaga dan dapat dimanfaatkan sebagai sumber protein hewani alami. Seperti dilansir Triyanto dkk. (2019); Lende & Khileri (2021), menemukan bahwa ikan menggunakan tumbuhan air untuk meletakkan telur dan berkembang biak di permukaan daun tumbuhan air, di antara tumbuhan berdaun halus, dan di bawah tumbuhan air.

Oleh karena itu, jenis tumbuhan yang disukai oleh ikan ini perlu dipertahankan dan ditingkatkan kesuburannya untuk menjamin perkembangan ikan air tawar, terutama yang hidup di rawa-rawa. Hal ini perlu disebarluaskan kepada masyarakat yang tinggal di sekitar rawa melalui pendidikan atau penyuluhan tentang potensi, ancaman, dan konservasi lahan rawa, khususnya keberadaan tumbuhan air terhadap keberadaan ikan air tawar di habitat rawa. Masyarakat terbiasa membuang tanaman ini di sekitar rawa karena dianggap gulma atau mengganggu perahu mereka. Menurut Fuller et al. (1998) keterpaduan antara tutupan vegetasi dan keanekaragaman hayati lainnya seperti ikan dapat digunakan untuk membantu perencanaan konservasi.

Selain itu, kami menemukan setiap ikan yang hidup di rawa tidak pernah menggunakan satu tanaman bersama-sama untuk membesarkan anak di waktu dan tempat yang sama. Dengan demikian, satu tanaman hanya digunakan oleh satu jenis ikan dalam setiap pemijahan. Keanekaragaman jenis tumbuhan air di rawa mempengaruhi aktivitas, pertumbuhan, dan pembentukan teritorial suatu spesies ikan rawa. Seperti yang dijelaskan oleh Gause (Odum, 1993) bahwa tidak ada spesies yang sama menggunakan sumber daya yang sama pada waktu yang sama, hal ini juga berlaku untuk ikan dalam menggunakan tanaman air sebagai relung untuk bertelur, dan membesarkan anak-anaknya. Dengan demikian dapat dikatakan, bahwa ikan memilih tumbuhan tertentu sebagai tempat bertelur dan membesarkan anak-anaknya secara khusus tanpa kehadiran ikan lain untuk melakukan hal yang sama. Penelitian oleh Mouton et al. (2010) menunjukkan perbedaan dalam sejarah kehidupan atau bahkan aliran gen kumpulan ikan dapat menghasilkan relung realisasi yang berbeda. Haller

(2009); Kosta dkk. (2010); Ismail dkk. (2018) menyatakan kelimpahan tumbuhan air memicu pertumbuhan dan kondisi ikan. Keterbatasan dan kelebihan tumbuhan air di daerah rawa dapat mengurangi kelimpahan ikan. Korelasi negatif yang dapat terjadi menurut (Mirmanto, 2009) adalah adanya persaingan antar individu bibit pada awal pertumbuhan bukan antar spesies.

SIMPULAN

Berdasarkan hasil penelitian terhadap tumbuhan rawa yang berpotensi sebagai *Niche* ikan rawa di tiga kawasan rawa Kalimantan Indonesia, ditemukan 26 spesies tumbuhan air yang digunakan oleh 17 spesies ikan rawa untuk bertelur dan membesarkan anak dengan memilih tumbuhan tertentu tanpa kehadiran ikan lain untuk melakukan hal yang sama. Tumbuhan air yang dominan atau paling banyak dimanfaatkan oleh ikan yang hidup di rawa sebagai *Niche* bertelur dan pemeliharaan anak adalah *Eichornia crassipes* semua spesies ikan air tawar yang ditemukan sebanyak 17 spesies ikan, kemudian disusul oleh *Pistia stratoites* sebanyak 12 spesies ikan, *Cyperus digitatus, Lemna minor, Nelumbo nucifera, Utricularia aurea, Crinum asiaticum* masing-masing sebanyak 9 spesies ikan, *Diplazium esculentum, Hymenachne amplexicaulis, Ipomoea aquatica, Nymphaea alba, Salvinia natans, Stenochlaena palustris, Phaspalum conjugatum masin-masing* sebanyak 8 spesies ikan, *Zoysia matrella* sebanyak 7 spesies ikan, *Limnocharis flava* dan *Salvinia molesta* sebanyak 6 spesies ikan, *Hydrocharis morsus, Neptunia oleracea, Salvinia minima* maisng-masing sebanyak 5 spesies ikan, *Caladium sp*. sebanyak 4 ikan, *Azolla pinnata, Lemna perpusilla, Megathyrsus maximus* masing-masing sebanyak 3 spesies ikan), dan *Nymphaea lotus* sebanyak 2 spesies ikan. ….

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Tumbuhan air sebagai niche (bertelur dan memelihara anak) ikan air tawar pada habitat rawa di Kalimantan Selatan Indonesia

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Abstract. Sekitar 208.893 ha dari total luas wilayah Kalimantan Selatan merupakan rawa. Vegetasi rawa hidup bersimbiosis dengan hewan di sekitarnya. Ditemukan ~~Kami menemukan~~ banyak penelitian yang meneliti keduanya secara terpisah, tetapi interaksi spesifik antara spesies hewan air dan tumbuhan rawa jarang diamati di sini. Hewan air seperti ikan sangat bergantung terhadap keberadaan tumbuhan yang hidup di rawa sebagai *Niche* atau mikrohabitat khususnya untuk berlindung dan berkembang biak. Tujuan penelitian ini adalah untuk mengetahui tumbuhan rawa yang dimanfaatkan sebagai Niche ikan air tawar untuk bertelur dan memelihara anak. Metode penelitian yang digunakan adalah penelitian deskriptif kwantitatif. Populasi penelitian adalah semua tumbuhan yang ditemukan di tiga habitat rawa Kalimantan Selatan Indonesia, yaitu Rawa Kabupaten Hulu Sungai Utara, Rawa Kabupaten Tanah Laut, dan Rawa Kabupaten Barito Kuala. Sampel penelitian ditetapkan secara Purposive Random Sampling pada setiap rawa terhadap jenis-jenis tumbuhan yang ditemukan telur dan anakan ikan. Data penelitian ~~dianalisa~~ dianalisis secara deskriptif ~~diskriptif~~ dengan menggunakan Pustaka (tidak jelas maksudnya). Hasil penelitian ditemukan 26 spesies tumbuhan yang digunakan oleh 17 spesies ikan rawa untuk bertelur dan membesarkan anak.

Keywords: Tumbuhan rawa, tempat berpijah dan memelihara anak ikan

INTRODUCTION

Rawa merupakan ekosistem yang tergenang air, asam, anoksik, dan oligotrofik (Too et al., 2021). Rawa berdistribusi pada ekosistem sebagai daerah dataran banjir (Phiri et al., 2021), bank benih (Lei & Middleton, 2021), transisi air antara daratan dan atmosfer (Ohkubo et al., 2021), dan di laboratorium sebagai media untuk budidaya organisme dan studi kinetik (Padil et al., 2021). Dalam satu dekade terakhir, ekosistem rawa mengalami banyak fenomena seperti kebakaran hutan yang lebih sering terjadi pada musim kemarau (Kubik et al., 2020), perubahan lingkungan dan iklim (Lei & Middleton, 2021) yang mempengaruhi siklus karbon (Liu et al., 2020), dan populasi hewan rawa semakin berkurang karena berkurangnya relung (Paul et al., 2020).

Rawa terbesar di Kalimantan Selatan adalah rawa lebak, baik secara musiman maupun permanen. Luas lahan rawa lebak di Kalimantan Selatan sekitar 208.893 ha dengan vegetasi yang didominasi oleh tumbuhan perdu dan perdu. Vegetasi hutan rawa mampu beradaptasi dengan daerah yang anaerobik dan tergenang secara musiman atau permanen. Whetstone (2009) menyatakan vegetasi tumbuhan rawa berdasarkan keberadaannya di air dikelompokkan menjadi tiga kelompok yaitu tumbuhan permukaan, tumbuhan terapung dan tumbuhan terendam. Tumbuhan permukaan memiliki akar di dasar air dengan daun memanjang ke atas hingga ke permukaan air, misalnya Saggittaria sinensis dan Phragmites communis. Sementara itu, Goel (2006) menyatakan bahwa tumbuhan terapung adalah tumbuhan yang akarnya menggantung di air atau tidak menyentuh dasar air, misalnya Nymphaea sp. dan Nelumbo sp. Tumbuhan terendam adalah tumbuhan yang hidup sepenuhnya di air, misalnya Hydrilla verticillate, Najas minor, Chara vulgaris, dan Ceratophyllum demersum. Hasil penelitian yang dilakukan oleh Djufri dkk. (2016) menemukan 41 jenis tumbuhan herba di hutan rawa gambut Tripa, Indonesia.

Ekosistem rawa gambut merupakan salah satu kawasan penting dan merupakan habitat yang memiliki endemisme spesies yang tinggi (Joni et al., 2015). Vegetasi yang berbeda dalam zonasi ekosistem ini menunjukkan pembentukan relung. Namun, ada variasi spasial skala kecil yang menunjukkan sifat stokastik vegetasi (DiMichele et al., 2017). Vegetasi berbuah pahit dan berbuah manis juga dapat membentuk relung ekologi yang berbeda (Vihotogbé et al., 2019). Area niche dan keragaman trofik dapat menunjukkan penggunaan sumber daya sesuai dengan ketersediaan trofik, terlepas dari ukuran atau jenis kelamin (Correia, 2002). Rawa ridge-hollow dapat menghasilkan kerangka relung ekologi dalam media berair asam kuat (Rybina et al., 2014), yang dapat digunakan sebagai prediksi tentang apa tanaman air dan hewan air dapat hidup di daerah tersebut. Ndehedehe et al., (2020) menyatakan pengelolaan habitat perairan dapat mendukung terpeliharanya keanekaragaman hayati perairan. Menurut Kłosowski & Jabłońska (2009), selain variabilitas yang luas, kondisi habitat di badan air dibedakan berdasarkan dominasi spesies tumbuhan air yang berasosiasi dengan habitat tertentu.

Tumbuhan air di habitat vegetasi rawa berperan penting bagi kehidupan ikan (Kurniawan & Paramita, 2019). Hewan air seperti ikan sangat bergantung pada keberadaan tumbuhan yang hidup di rawa-rawa sebagai relung atau habitat

mikro, terutama untuk tempat berteduh dan berkembang biak (Raharjo, 2018). Kelimpahan tumbuhan air berkorelasi positif dengan populasi ikan. Habitat dengan tanaman air dalam jumlah sedang menyediakan lingkungan yang optimal bagi banyak ikan untuk meningkatkan keanekaragaman, makan, pertumbuhan, dan reproduksi ikan. Sebaliknya, vegetasi yang terbatas dan berlebihan dapat menurunkan laju pertumbuhan ikan pada 75% hingga 85% dari cakupan komunitas tumbuhan (Ismail et al., 2018). Tumbuhan air dimanfaatkan ikan untuk bertelur di permukaan daun tumbuhan air atau di antara tumbuhan berdaun halus pada vegetasi mangrove (Triyanto et al., 2019). Contohnya, induk ikan Chlaria batracus dan Ikan Melanotaenia sp. biasanya membentuk pasangan, bertelur, dan melindungi telur dan biji dari bahaya di bawah tanaman air (Lende & Khileri, 2021).

Setiap jenis tumbuhan memiliki ciri morfologi yang spesifik untuk beradaptasi dengan habitatnya (Steenis, 2013). Karakteristik morfologi tersebut diduga dimanfaatkan oleh spesies ikan air tawar sebagai habitat hidup dan tumbuh. Berdasarkan hasil penelitian Ismail et al. (2018) dan jurnal ilmiah lainnya, belum ditemukan hasil penelitian yang melaporkan jenis tumbuhan tertentu yang dipilih oleh jenis ikan tertentu sebagai tempat bertelur dan membesarkan anak-anaknya. Oleh karena itu, penelitian ini bertujuan untuk memperoleh informasi tentang jenis tumbuhan rawa yang dipilih oleh ikan air tawar sebagai relung dalam bertelur dan memelihara benihnya.

MATERIALS AND METHODS

Penelitian ini dilaksanakan di tiga habitat rawa Kalimantan Selatan Indonesia, Rawa Kabupaten Hulu Sungai Selatan, Rawa Kabupaten Tanah Laut, dan Kabupaten Barito Kuala pada bulan April 2021. Jenis penelitian yang digunakan adalah penelitian deskriptif observatif. Luas rawa pengamatan di Rawa Kabupaten Hulu Sungai Utara adalah 92,5 Ha, Rawa Kabupaten Tanah Laut adalah 56,7 Ha, dan Rawa Kabupaten Barito Kuala adalah 47,2 Ha (Gambar 1). Sampel penelitian ditetapkan secara Purposive Random Sampling pada setiap rawa dengan mengamati dan mendokumenkan jenis-jenis tumbuhan yang ditemukan telur dan anakan ikan sebagai data *Niche* ikan rawa untuk bertelur dan membesarkan anak. Penentuan telur dan anakan ikan didasarkan atas kehadiran induk ikan di sekitar telur dan anakan ikan tersebut. Data penelitian dianalisa secara diskriptif dengan menggunakan pustaka.

Gambar 1. Lokasi Penelitian

RESULTS AND DISCUSSION

Berdasarkan hasil penelitian terhadap tumbuhan rawa yang berpotensi sebagai *Niche* ikan rawa di tiga kawasan rawa Kalimantan Indonesia, ditemukan 26 spesies tumbuhan air yang digunakan oleh 17 spesies ikan rawa untuk bertelur dan

membesarkan anak seperti yang ditampilkan pada Tabel 1. Hasil penelitian ini lebih banyak ditemukan tumbuhan air yang digunakan sebagai niche ikan daripada penelitian yang dilakukan oleh Ismail, *et.al*. (2018) yang menemukan 8 spesies tumbuhan, yaitu; *Lemna minor, Polygonum barbatum, Eichhornia crassipes, Pistia stratiotes, Neptunia oleracea, Hydrilla verticillata, Salvinia molesta, Phragmites australis, dan Azolla pinnata.* Akan tetapi hasil penelitian tersebut tidak menjelaskan khusus tumbuhan apa saja yang paling disukai oleh spesies-spesies ikan air tawar.

Tabel 1. Tumbuhan Rawa yang Berpotensi Sebagai Niche Ikan Rawa

No.	Spesies Tumbuhan	Spesies Ikan																
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**
1	*Azolla pinnata*		A													A	A	
2	*Caladium* sp.		A							A						A		A
3	*Cyperus digitatus*		T	T	A	T				A			A			A	A	A
4	*Diplazium esculentum*	A	T	T				A						A		A		A
5	*Phaspalum conjugatum*	A		T	A	T		A		A				A			A	
6	*Eichornia crassipes*	A	T	T	A	A	T	A	A	A	T	A	A	A	A	A	A	T
7	*Hydrilla verticillata*														A			
8	*Hydrocharis Morsus*	A						A						A		A		A
9	*Hymenachne amplexicaulis*	A	T	T		T		A						A		A		T
10	*Ipomoea aquatica*		T	A	A				A	A		A			T		A	
11	*Lemna Minor*		T	T	A	T					T	A			A	A		T
12	*Lemna perpusilla*														A	A		T
13	*Limnocharis flava*	A						A						A		A	A	A
14	*Megathyrsus maximus*				A	A				A								
15	*Nelumbo nucifera*		A	T	A	T	T					A				A	A	A
16	*Neptunia oleracea*			A			A		A							A		T
17	*Nymphaea alba*		A	T	A						A		T		A	A		T
18	*Nymphaea lotus* L.															A		T
19	*Pistia stratoites*	A	T	A	A	T		A	A			A		A		A	A	A
20	*Salvinia minima*		T	A					A							A		A
21	*Salvinia molesta*									A		A			T	A	A	T
22	*Salvinia natans*		T	T		T			A	A						A	A	T
23	*Stenochlaena palustris*	A						A		A			A	A		A	A	A
24	*Utricularia aurea*	A	T	T	A	T		A						A		A		A
25	*Zoysia matrella*	A		A				A	A					A		A		T
26	*Crinum asiaticum*		T		A				A			A	A	A	T		A	T

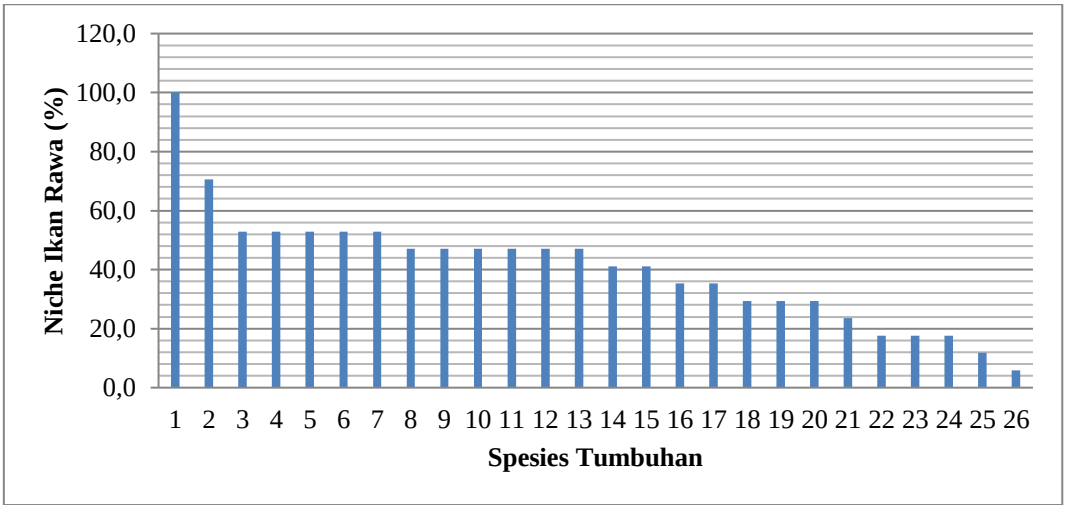
Keterangan : T = Telur, A = Anakan

A	*Channa striata*	G	*Channa micropeltes*	M	*Channa lucius*
B	*Anabas testudineus*	H	*Cyprinus carpio*	N	*Rasbora argyrotaenia*
C	*Trichogaster trichopterus*	I	*Pampus argenteus*	O	*Mystus Scopoli*
D	*Rasbora dusonensis*	J	*Clarias batrachus*	P	*Osteochilus hasselti*
E	*Trichogaster pectoralis*	K	*Criptopterus spp*	Q	*Oxyeleotris marmorata*
F	*Helestoma temminkii*	L	*Hemibagrus nemurus*		

Berdasarkan penelitian yang dilakukan pada bulan April 2021 terlihat, bahwa keberadaan ikan pada tumbuhan rawa ada 2 bentuk yaitu masih berbentuk telur yang ditunjukkan keberadaan buih di sekitar tumbuhan dan berupa anakan (Tabel 1 dan Gambar 2). Hal tersebut menunjukkan, bahwa masa reproduksi ikan air tawar berbeda-beda atau tidak bersamaan. Seperti yang dilaporkan oleh Setyaningrum dan Wibowo (2017), kemampuan reproduksi pada 5 species ikan (*Cyprinus carpio, Barbonymus gonionatus, Osteochillus vittatus, Oreochromis niloticus* dan *Clarias gariepinus*) menunjukkan perbedaan. Seperti yang dijelaskan Devkota & Kathayat (2020), bahwa perubahan iklim sangat mempengaruhi reproduksi, perkembangan, struktur, dan kelimpahan populasi ikan air tawar. Selain itu potensi reproduksi ikan tergantung pada perkembangan gonad sampai ikan memijah dan menghasilkan benih. Berdasarkan informasi masyarakat yang tinggal di ketiga kawasan rawa yang diteliti, musim kawin bagi ikan di daerah tersebut yang ditunjukkan oleh adanya telur dan anakan ikan adalah pada bulan Februari sampai Agustus.

Gambar 2. Keterdapatan Telur dan Ikan Air Tawar Pada Tumbuhan

Berdasarkan Gambar 3 terlihat, bahwa tumbuhan air yang dominan atau paling banyak dimanfaatkan oleh ikan yang hidup di rawa sebagai *Niche* bertelur dan pemeliharaan anak adalah *Eichornia crassipes* sebesar 100% semua spesies ikan air tawar yang ditemukan (17 spesies ikan), kemudian disusul oleh *Pistia stratoites* sebesar 70,6% (12 spesies ikan), *Cyperus digitatus* 52,9% (9 spesies ikan), *Lemna minor* 52,9% (9 spesies ikan), *Nelumbo nucifera* 52,9% (9 spesies ikan), *Utricularia aurea* 52,9% (9 spesies ikan), *Crinum asiaticum* 52,9% (9 spesies ikan), *Diplazium esculentum* 47,1% (7 spesies ikan), *Hymenachne amplexicaulis* 47,1% (8 spesies ikan), *Ipomoea aquatica* 47,1% (8 spesies ikan), *Nymphaea alba* 47,1% (8 spesies ikan), *Salvinia natans* 47,1% (8 spesies ikan), *Stenochlaena palustris* 47,1% (8 spesies ikan), *Phaspalum conjugatum* 47,1% (8 spesies ikan), *Bulbostylis juncoides* 41,2% (7 spesies ikan), *Limnocharis flava* 35,6% (6 spesies ikan), *Salvinia molesta* 35,3% (6 spesies ikan), *Hydrocharis Morsus* 29,4% (5 spesies ikan), *Neptunia oleracea* 29,4% (5 ikan), *Salvinia minima* 29,4% (5 ikan), *Caladium sp*. 23,5% (4 ikan), *Azolla pinnata* 17,6% (3 spesies ikan), *Lemna perpusilla* 17,6% (3 spesies ikan), *Bulbostylis barbata* 17,6% (3 spesies ikan), *Nymphaea lotus* 11,8% (2 spesies ikan). Sedangkan tumbuhan yang paling sedikit dimanfaatkan oleh ikan untuk bertelur dan membesarkan anak adalah tumbuhan *Hydrilla verticillata* yaitu sebesar 5.9% (1 spesies ikan). Hal tersebut menunjukkan, bahwa spesies tumbuhan rawa menentukan jenis-jenis ikan air tawar untuk bertelur dan memelihara anak.



Keterangan :

1. *Eichornia crassipes*
2. *Pistia stratoites*
3. *Cyperus digitatus*
4. *Lemna minor*
5. *Nelumbo nucifera*
6. *Utricularia aurea*
7. *Crinum asiaticum*
8. *Diplazium esculentum*
9. *Hymenachne amplexicaulis*
10. *Ipomoea aquatica*
11. *Nymphaea alba*
12. *Salvinia natans*
13. *Stenochlaena palustris*
14. *Phaspalum conjugatum*
15. *Bulbostylis barbata*
16. *Limnocharis flava*
17. *Salvinia molesta*
18. *Hydrocharis Morsus*
19. *Neptunia oleracea*
20. *Salvinia minima*
21. *Caladium sp.*
22. *Azolla pinnata*
23. *Lemna perpusilla*
24. *Bulbostylis juncoides*
25. *Nymphaea lotus* L
26. *Hydrilla verticillata*

Gambar 3. Tumbuhan Rawa yang Berpotensi Sebagai Niche Ikan Rawa (%)

Berdasarkan hasil penelitian, ciri morfologi tumbuhan air yang dimanfaatkan ikan sebagai relung untuk bertelur dan membesarkan anak adalah ciri morfologi daun dan akar tumbuhan tersebut. Jenis tumbuhan Eichornia crassipes merupakan tumbuhan air dengan relung terluas untuk berbagai jenis ikan rawa. Sebagai gambaran, berikut disajikan bagaimana ciri-ciri tumbuhan Eichornia crassipes sebagai tumbuhan yang paling disukai ikan untuk bertelur dan beternak

ikan muda. *Eichornia crassipes* adalah tumbuhan berhabitus herba makrofit atau tumbuhan yang sepanjang hidupnya mengapung di atas air. Tumbuhan ini memiliki helai daun yang tersusun dalam bentuk roset, berbentuk bulat telur lebar yang sangat menguntungkan ikan untuk menempelkan telur bagi ikan yang meletakkan telurnya pada permukaan datar. Selain itu helaian daun yang lebar akan melindungi telur dan anak ikan dari efek sinar matahari langsung. Sistem perakaran eceng gondok adalah serabut dengan banyak akar-akar kecil yang subur dan lebat akan menjadi tempat yang sesuai bagi ikan yang peletakan telurnya diantara akar-akar kecil tersebut. Selain itu akar-akar kecil yang subur dan lebat banyak ditemukan bahan-bahan organik dan anorganik yang dibutuhkan sebagai sumber makanan bagi anak ikan. Warna akar yang hitam akan melindungi telur dan anak-anak ikan dari bahaya predator. Karakteristik morfologi yang seperti itulah yang menyebabkan tumbuhan ini paling disukai oleh ikan air tawar untuk bertelur dan memelihara anaknya. Dalam penelitian ini semua ikan yang ditemukan sebanyak 17 spesies air tawar yang hidup di rawa bertelur, dan memelihara anaknya pada *Eichornia crassipes.* Hasil penelitian lain yang juga menemukan *Eichornia crassipes* sebagai niche ikan untuk melakukan reproduksi dilakukan oleh Whetstone (2009), Gettys (2009) dan Ismail, *et.al.* (2018).

Pistia stratoites memiliki daun memiliki macam daun tunggal. dengan tata letak daun roset akar yang lebat dan rapat, bentuk daun bangun sudip, tepi daun berlekuk, dengan permukaan daun halus bergaris-garis berambut, testur daun tebal dan lembut dengan panjang 1,3-10 cm dengan lebar 1,5-6 cm. Morfologi daun yang demikian sangat menguntungkan ikan untuk menempelkan atau meletakkan telur. Selain itu helaian daun yang berkumpul atau roset akan melindungi telur dan anak ikan dari efek sinar matahari maupun arus atau gelombang air. Akar tumbuhan ini masuk di dalam dasar air, sehingga tidak dapat dimanfaatkan oleh ikan untuk menempelkan atau meletakkan telur. Sementara itu pada *Hydrilla verticillate* hanya ditemukan ikan *Rasbora argyrotaenia* yang menggunakan tumbuhan tersebut sebagai tempat bertelur dan membesarkan anaknya. *Hydrilla verti*cillata merupakan berhabitus herba yang hidup di air menjalar rapat, dengan batang memiliki interkalar 0,7 cm-1,4 cm bercabang yang terdapat daun tunggal, dengan tata letak dalam lingkaran yang berjumlah 3-6 daun yang berbentuk daun lanset, tepi daun bergerigi, permukaan daun dengan panjang 0.6-2,5 cm dan lebar 1,2-5,5 cm. Sistem perakaran tumbuhan ini adalah serabut menancap di dasar air. Berdasarkan karakteristik morfologi tersebut, maka potensi tumbuhan sebagai niche untuk bertelur dan membesarkan anak hanya pada daun. Selain itu dengan habitusnya yang rapat, akan menjadi hambatan bagi ikan-ikan berukuran menengah dan besar untuk keperluan reproduksi tersebut. Sehingga hanya ikan yang berukuran kecil yang dapat memanfaatkan tumbuhan tersebut untuk bertelur, dan membesarkan anak yang dalam penelitian ini adalah *Rasbora argyrotaenia.* Hasil penelitian lain yang juga menemukan *Hydrilla verticillate* sebagai niche ikan dilaporkan oleh Ismail, *et.al*. (2018).

Berdasarkan uraian di atas, maka ciri morfologi bentuk, ukuran, jumlah dan daun yang mengapung dipermukaan, bentuk dan jumlah serabut akar yang mengapung di air paling banyak digunakan oleh ikan air tawar untuk bertelur dan memelihara benihnya. Semakin besar ukuran daun dan jumlah daun yang menutupi permukaan air, semakin kasar permukaan dan tepi daun, semakin rapat sistem akar serabut tumbuhan di dalam air (bukan di dalam tanah), semakin banyak ikan memilih tumbuhan tersebut untuk bertelur dan membesarkan anak. Selain itu, morfologi daun yang lebar dan melimpah akan memperlambat aliran air oleh arus, perairan di sekitarnya menjadi tenang, sehingga efektif untuk bertelur dan beternak ikan. Rimpang dan akar yang padat di dalam air dapat menahan dan mengikat mineral dan bahan organik yang dibutuhkan oleh ikan muda untuk tumbuh. Tumbuhan air yang berdaun lebar di dalam atau dipermukaan air memiliki peran penting sebagai oksidator di dalam air, sehingga sangat efisien dalam mengikat karbondioksida di dalam air dan melepaskannya menjadi oksigen yang bermanfaat bagi ikan muda. Konsep gulma di habitat rawa bila dilihat dari sudut pandang pentingnya menjaga keanekaragaman ikan sebaiknya tidak digunakan, karena habitat rawa bukan merupakan kawasan yang digunakan untuk budidaya tanaman produktif. Keberadaan tumbuhan air di habitat rawa perlu dijaga agar ikan air tawar yang dibutuhkan oleh masyarakat yang tinggal di daerah tersebut dapat selalu terjaga dan dapat dimanfaatkan sebagai sumber protein hewani alami. Seperti dilansir Triyanto dkk. (2019); Lende & Khileri (2021), menemukan bahwa ikan menggunakan tumbuhan air untuk meletakkan telur dan berkembang biak di permukaan daun tumbuhan air, di antara tumbuhan berdaun halus, dan di bawah tumbuhan air.

Oleh karena itu, jenis tumbuhan yang disukai oleh ikan ini perlu dipertahankan dan ditingkatkan kesuburannya untuk menjamin perkembangan ikan air tawar, terutama yang hidup di rawa-rawa. Hal ini perlu disebarluaskan kepada masyarakat yang tinggal di sekitar rawa melalui pendidikan atau penyuluhan tentang potensi, ancaman, dan konservasi lahan rawa, khususnya keberadaan tumbuhan air terhadap keberadaan ikan air tawar di habitat rawa. Masyarakat terbiasa membuang tanaman ini di sekitar rawa karena dianggap gulma atau mengganggu perahu mereka. Menurut Fuller et al. (1998) keterpaduan antara tutupan vegetasi dan keanekaragaman hayati lainnya seperti ikan dapat digunakan untuk membantu perencanaan konservasi.

Selain itu, kami menemukan setiap ikan yang hidup di rawa tidak pernah menggunakan satu tanaman bersama-sama untuk membesarkan anak di waktu dan tempat yang sama. Dengan demikian, satu tanaman hanya digunakan oleh satu jenis ikan dalam setiap pemijahan. Keanekaragaman jenis tumbuhan air di rawa mempengaruhi aktivitas, pertumbuhan, dan pembentukan teritorial suatu spesies ikan rawa. Seperti yang dijelaskan oleh Gause (Odum, 1993) bahwa tidak ada spesies yang sama menggunakan sumber daya yang sama pada waktu yang sama, hal ini juga berlaku untuk ikan dalam menggunakan tanaman air sebagai relung untuk bertelur, dan membesarkan anak-anaknya. Dengan demikian dapat dikatakan, bahwa ikan memilih tumbuhan tertentu sebagai tempat bertelur dan membesarkan anak-anaknya secara khusus tanpa kehadiran ikan lain untuk melakukan hal yang sama. Penelitian oleh Mouton et al. (2010) menunjukkan perbedaan dalam sejarah kehidupan atau bahkan aliran gen kumpulan ikan dapat menghasilkan relung

realisasi yang berbeda. Haller (2009); Kosta dkk. (2010); Ismail dkk. (2018) menyatakan kelimpahan tumbuhan air memicu pertumbuhan dan kondisi ikan. Keterbatasan dan kelebihan tumbuhan air di daerah rawa dapat mengurangi kelimpahan ikan. Korelasi negatif yang dapat terjadi menurut (Mirmanto, 2009) adalah adanya persaingan antar individu bibit pada awal pertumbuhan bukan antar spesies.

SIMPULAN

Berdasarkan hasil penelitian terhadap tumbuhan rawa yang berpotensi sebagai *Niche* ikan rawa di tiga kawasan rawa Kalimantan Indonesia, ditemukan 26 spesies tumbuhan air yang digunakan oleh 17 spesies ikan rawa untuk bertelur dan membesarkan anak dengan memilih tumbuhan tertentu tanpa kehadiran ikan lain untuk melakukan hal yang sama. Tumbuhan air yang dominan atau paling banyak dimanfaatkan oleh ikan yang hidup di rawa sebagai *Niche* bertelur dan pemeliharaan anak adalah *Eichornia crassipes* semua spesies ikan air tawar yang ditemukan sebanyak 17 spesi. es ikan, kemudian disusul oleh *Pistia stratoites* sebanyak 12 spesies ikan, *Cyperus digitatus, Lemna minor, Nelumbo nucifera, Utricularia aurea, Crinum asiaticum* masing-masing sebanyak 9 spesies ikan, *Diplazium esculentum, Hymenachne amplexicaulis, Ipomoea aquatica, Nymphaea alba, Salvinia natans, Stenochlaena palustris, Phaspalum conjugatum masin-masing* sebanyak 8 spesies ikan, *Zoysia matrella* sebanyak 7 spesies ikan, *Limnocharis flava* dan *Salvinia molesta* sebanyak 6 spesies ikan, *Hydrocharis morsus, Neptunia oleracea, Salvinia minima* maisng-masing sebanyak 5 spesies ikan, *Caladium sp*. sebanyak 4 ikan, *Azolla pinnata, Lemna perpusilla, Megathyrsus maximus* masing-masing sebanyak 3 spesies ikan), dan *Nymphaea lotus* sebanyak 2 spesies ikan.

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Tumbuhan air sebagai niche (bertelur dan memelihara anak) ikan air tawar pada habitat rawa di Kalimantan Selatan Indonesia

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Abstract. Sekitar 208.893 ha dari total luas wilayah Kalimantan Selatan merupakan rawa. Vegetasi rawa hidup bersimbiosis dengan hewan di sekitarnya. Kami menemukan banyak penelitian yang meneliti keduanya secara terpisah, tetapi interaksi spesifik antara spesies hewan air dan tumbuhan rawa jarang diamati di sini. Hewan air seperti ikan sangat bergantung terhadap keberadaan tumbuhan yang hidup di rawa sebagai *Niche* atau mikrohabitat khususnya untuk berlindung dan berkembang biak. Tujuan penelitian ini adalah untuk mengetahui tumbuhan rawa yang dimanfaatkan sebagai Niche ikan air tawar untuk bertelur dan memelihara anak. Metode penelitian yang digunakan adalah penelitian deskriptif kwantitatif. Populasi penelitian adalah semua tumbuhan yang ditemukan di tiga habitat rawa Kalimantan Selatan Indonesia, yaitu Rawa Kabupaten Hulu Sungai Utara, Rawa Kabupaten Tanah Laut, dan Rawa Kabupaten Barito Kuala. Sampel penelitian ditetapkan secara Purposive Random Sampling pada setiap rawa terhadap jenis-jenis tumbuhan yang ditemukan telur dan anakan ikan. Data penelitian dianalisa secara diskriptif dengan menggunakan pustaka. Hasil penelitian ditemukan 26 spesies tumbuhan yang digunakan oleh 17 spesies ikan rawa untuk bertelur dan membesarkan anak.

Keywords: Tumbuhan rawa, tempat berpijah dan memelihara anak ikan

INTRODUCTION

Rawa merupakan ekosistem yang tergenang air, asam, anoksik, dan oligotrofik (Too et al., 2021). Rawa berdistribusi pada ekosistem sebagai daerah dataran banjir (Phiri et al., 2021), bank benih (Lei & Middleton, 2021), transisi air antara daratan dan atmosfer (Ohkubo et al., 2021), dan di laboratorium sebagai media untuk budidaya organisme dan studi kinetik (Padil et al., 2021). Dalam satu dekade terakhir, ekosistem rawa mengalami banyak fenomena seperti kebakaran hutan yang lebih sering terjadi pada musim kemarau (Kubik et al., 2020), perubahan lingkungan dan iklim (Lei & Middleton, 2021) yang mempengaruhi siklus karbon (Liu et al., 2020), dan populasi hewan rawa semakin berkurang karena berkurangnya relung (Paul et al., 2020).

Rawa terbesar di Kalimantan Selatan adalah rawa lebak, baik secara musiman maupun permanen. Luas lahan rawa lebak di Kalimantan Selatan sekitar 208.893 ha dengan vegetasi yang didominasi oleh tumbuhan perdu dan perdu. Vegetasi hutan rawa mampu beradaptasi dengan daerah yang anaerobik dan tergenang secara musiman atau permanen. Whetstone (2009) menyatakan vegetasi tumbuhan rawa berdasarkan keberadaannya di air dikelompokkan menjadi tiga kelompok yaitu tumbuhan permukaan, tumbuhan terapung dan tumbuhan terendam. Tumbuhan permukaan memiliki akar di dasar air dengan daun memanjang ke atas hingga ke permukaan air, misalnya Saggittaria sinensis dan Phragmites communis. Sementara itu, Goel (2006) menyatakan bahwa tumbuhan terapung adalah tumbuhan yang akarnya menggantung di air atau tidak menyentuh dasar air, misalnya Nymphaea sp. dan Nelumbo sp. Tumbuhan terendam adalah tumbuhan yang hidup sepenuhnya di air, misalnya Hydrilla verticillate, Najas minor, Chara vulgaris, dan Ceratophyllum demersum. Hasil penelitian yang dilakukan oleh Djufri dkk. (2016) menemukan 41 jenis tumbuhan herba di hutan rawa gambut Tripa, Indonesia.

Ekosistem rawa gambut merupakan salah satu kawasan penting dan merupakan habitat yang memiliki endemisme spesies yang tinggi (Joni et al., 2015). Vegetasi yang berbeda dalam zonasi ekosistem ini menunjukkan pembentukan relung. Namun, ada variasi spasial skala kecil yang menunjukkan sifat stokastik vegetasi (DiMichele et al., 2017). Vegetasi berbuah pahit dan berbuah manis juga dapat membentuk relung ekologi yang berbeda (Vihotogbé et al., 2019). Area niche dan keragaman trofik dapat menunjukkan penggunaan sumber daya sesuai dengan ketersediaan trofik, terlepas dari ukuran atau jenis kelamin (Correia, 2002). Rawa ridge-hollow dapat menghasilkan kerangka relung ekologi dalam media berair asam kuat (Rybina et al., 2014), yang dapat digunakan sebagai prediksi tentang apa tanaman air dan hewan air dapat hidup di daerah tersebut. Ndehedehe et al., (2020) menyatakan pengelolaan habitat perairan dapat mendukung terpeliharanya keanekaragaman hayati perairan. Menurut Kłosowski & Jabłońska (2009), selain variabilitas yang luas, kondisi habitat di badan air dibedakan berdasarkan dominasi spesies tumbuhan air yang berasosiasi dengan habitat tertentu.

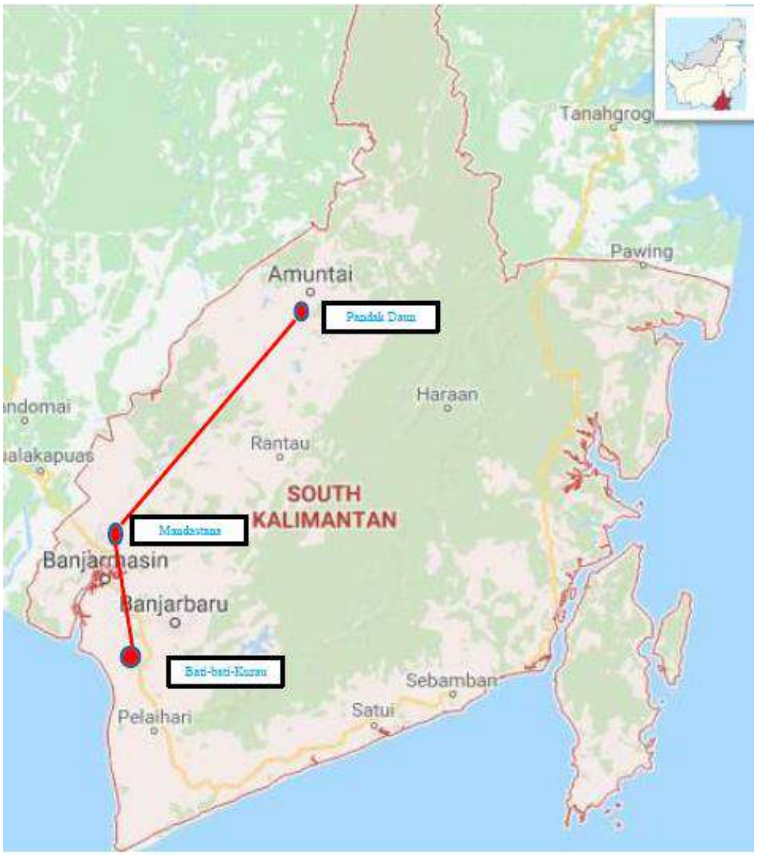
Tumbuhan air di habitat vegetasi rawa berperan penting bagi kehidupan ikan (Kurniawan & Paramita, 2019). Hewan air seperti ikan sangat bergantung pada keberadaan tumbuhan yang hidup di rawa-rawa sebagai relung atau habitat mikro, terutama untuk tempat berteduh dan berkembang biak (Raharjo, 2018). Kelimpahan tumbuhan air berkorelasi

positif dengan populasi ikan. Habitat dengan tanaman air dalam jumlah sedang menyediakan lingkungan yang optimal bagi banyak ikan untuk meningkatkan keanekaragaman, makan, pertumbuhan, dan reproduksi ikan. Sebaliknya, vegetasi yang terbatas dan berlebihan dapat menurunkan laju pertumbuhan ikan pada 75% hingga 85% dari cakupan komunitas tumbuhan (Ismail et al., 2018). Tumbuhan air dimanfaatkan ikan untuk bertelur di permukaan daun tumbuhan air atau di antara tumbuhan berdaun halus pada vegetasi mangrove (Triyanto et al., 2019). Contohnya, induk ikan Chlaria batracus dan Ikan Melanotaenia sp. biasanya membentuk pasangan, bertelur, dan melindungi telur dan biji dari bahaya di bawah tanaman air (Lende & Khileri, 2021).

Setiap jenis tumbuhan memiliki ciri morfologi yang spesifik untuk beradaptasi dengan habitatnya (Steenis, 2013). Karakteristik morfologi tersebut diduga dimanfaatkan oleh spesies ikan air tawar sebagai habitat hidup dan tumbuh. Berdasarkan hasil penelitian Ismail et al. (2018) dan jurnal ilmiah lainnya, belum ditemukan hasil penelitian yang melaporkan jenis tumbuhan tertentu yang dipilih oleh jenis ikan tertentu sebagai tempat bertelur dan membesarkan anak-anaknya. Oleh karena itu, penelitian ini bertujuan untuk memperoleh informasi tentang jenis tumbuhan rawa yang dipilih oleh ikan air tawar sebagai relung dalam bertelur dan memelihara benihnya.

MATERIALS AND METHODS

Penelitian ini dilaksanakan di tiga habitat rawa Kalimantan Selatan Indonesia, Rawa Kabupaten Hulu Sungai Selatan, Rawa Kabupaten Tanah Laut, dan Kabupaten Barito Kuala pada bulan April 2021. Jenis penelitian yang digunakan adalah penelitian deskriptif observatif. Luas rawa pengamatan di Rawa Kabupaten Hulu Sungai Utara adalah 92,5 Ha, Rawa Kabupaten Tanah Laut adalah 56,7 Ha, dan Rawa Kabupaten Barito Kuala adalah 47,2 Ha (Gambar 1). Sampel penelitian ditetapkan secara Purposive Random Sampling pada setiap rawa dengan mengamati dan mendokumenkan jenis-jenis tumbuhan yang ditemukan telur dan anakan ikan sebagai data *Niche* ikan rawa untuk bertelur dan membesarkan anak. Penentuan telur dan anakan ikan didasarkan atas kehadiran induk ikan di sekitar telur dan anakan ikan tersebut. Data penelitian dianalisa secara diskriptif dengan menggunakan pustaka.



Gambar 1. Lokasi Penelitian

RESULTS AND DISCUSSION

Berdasarkan hasil penelitian terhadap tumbuhan rawa yang berpotensi sebagai *Niche* ikan rawa di tiga kawasan rawa Kalimantan Indonesia, ditemukan 26 spesies tumbuhan air yang digunakan oleh 17 spesies ikan rawa untuk bertelur dan membesarkan anak seperti yang ditampilkan pada Tabel 1. Hasil penelitian ini lebih banyak ditemukan tumbuhan air yang

digunakan sebagai niche ikan daripada penelitian yang dilakukan oleh Ismail, *et.al*. (2018) yang menemukan 8 spesies tumbuhan, yaitu; *Lemna minor, Polygonum barbatum, Eichhornia crassipes, Pistia stratiotes, Neptunia oleracea, Hydrilla verticillata, Salvinia molesta, Phragmites australis, dan Azolla pinnata.* Akan tetapi hasil penelitian tersebut tidak menjelaskan khusus tumbuhan apa saja yang paling disukai oleh spesies-spesies ikan air tawar.

Tabel 1. Tumbuhan Rawa yang Berpotensi Sebagai Niche Ikan Rawa

No.	Spesies Tumbuhan	Spesies Ikan																
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**
1	*Azolla pinnata*		A													A	A	
2	*Caladium* sp.		A							A						A		A
3	*Cyperus digitatus*		T	T	A	T				A			A			A	A	A
4	*Diplazium esculentum*	A	T	T				A						A		A		A
5	*Phaspalum conjugatum*	A		T	A	T		A		A				A			A	
6	*Eichornia crassipes*	A	T	T	A	A	T	A	A	A	T	A	A	A	A	A	A	T
7	*Hydrilla verticillata*														A			
8	*Hydrocharis Morsus*	A						A						A		A		A
9	*Hymenachne amplexicaulis*	A	T	T		T		A						A		A		T
10	*Ipomoea aquatica*		T	A	A				A	A		A			T		A	
11	*Lemna Minor*		T	T	A	T					T	A			A	A		T
12	*Lemna perpusilla*														A	A		T
13	*Limnocharis flava*	A						A						A		A	A	A
14	*Megathyrsus maximus*				A	A				A								
15	*Nelumbo nucifera*		A	T	A	T	T					A				A	A	A
16	*Neptunia oleracea*			A			A		A							A		T
17	*Nymphaea alba*		A	T	A						A		T		A	A		T
18	*Nymphaea lotus* L.															A		T
19	*Pistia stratoites*	A	T	A	A	T		A	A			A		A		A	A	A
20	*Salvinia minima*		T	A					A							A		A
21	*Salvinia molesta*									A		A			T	A	A	T
22	*Salvinia natans*		T	T		T			A	A						A	A	T
23	*Stenochlaena palustris*	A						A		A			A	A		A	A	A
24	*Utricularia aurea*	A	T	T	A	T		A						A		A		A
25	*Zoysia matrella*	A		A				A	A					A		A		T
26	*Crinum asiaticum*		T		A				A			A	A	A	T		A	T

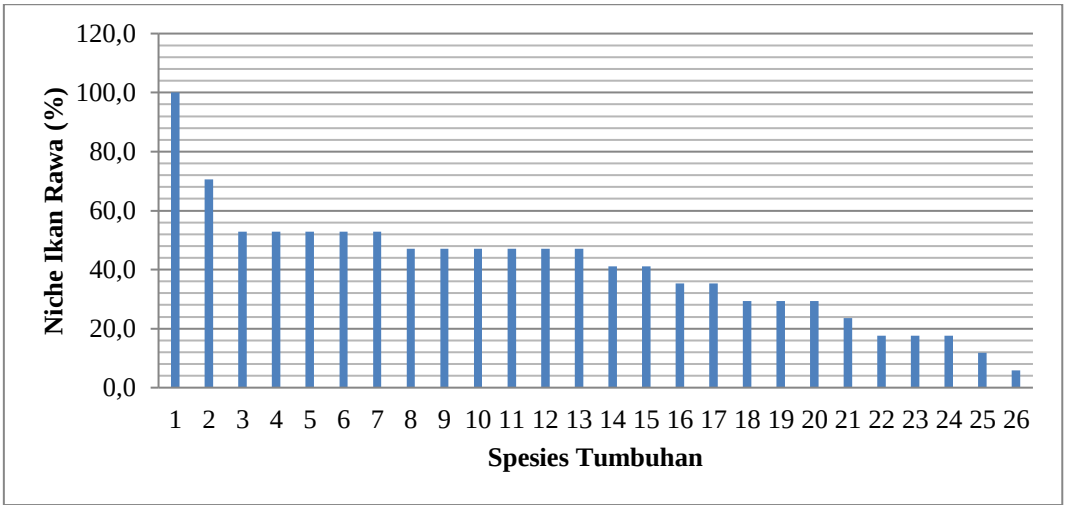
Keterangan : T = Telur, A = Anakan

A	*Channa striata*	G	*Channa micropeltes*	M	*Channa lucius*
B	*Anabas testudineus*	H	*Cyprinus carpio*	N	*Rasbora argyrotaenia*
C	*Trichogaster trichopterus*	I	*Pampus argenteus*	O	*Mystus Scopoli*
D	*Rasbora dusonensis*	J	*Clarias batrachus*	P	*Osteochilus hasselti*
E	*Trichogaster pectoralis*	K	*Criptopterus spp*	Q	*Oxyeleotris marmorata*
F	*Helestoma temminkii*	L	*Hemibagrus nemurus*		

Berdasarkan penelitian yang dilakukan pada bulan April 2021 terlihat, bahwa keberadaan ikan pada tumbuhan rawa ada 2 bentuk yaitu masih berbentuk telur yang ditunjukkan keberadaan buih di sekitar tumbuhan dan berupa anakan (Tabel 1 dan Gambar 2). Hal tersebut menunjukkan, bahwa masa reproduksi ikan air tawar berbeda-beda atau tidak bersamaan. Seperti yang dilaporkan oleh Setyaningrum dan Wibowo (2017), kemampuan reproduksi pada 5 species ikan (*Cyprinus carpio, Barbonymus gonionatus, Osteochillus vittatus, Oreochromis niloticus* dan *Clarias gariepinus*) menunjukkan perbedaan. Seperti yang dijelaskan Devkota & Kathayat (2020), bahwa perubahan iklim sangat mempengaruhi reproduksi, perkembangan, struktur, dan kelimpahan populasi ikan air tawar. Selain itu potensi reproduksi ikan tergantung pada perkembangan gonad sampai ikan memijah dan menghasilkan benih. Berdasarkan informasi masyarakat yang tinggal di ketiga kawasan rawa yang diteliti, musim kawin bagi ikan di daerah tersebut yang ditunjukkan oleh adanya telur dan anakan ikan adalah pada bulan Februari sampai Agustus.

Gambar 2. Keterdapatan Telur dan Ikan Air Tawar Pada Tumbuhan

Berdasarkan Gambar 3 terlihat, bahwa tumbuhan air yang dominan atau paling banyak dimanfaatkan oleh ikan yang hidup di rawa sebagai *Niche* bertelur dan pemeliharaan anak adalah *Eichornia crassipes* sebesar 100% semua spesies ikan air tawar yang ditemukan (17 spesies ikan), kemudian disusul oleh *Pistia stratoites* sebesar 70,6% (12 spesies ikan), *Cyperus digitatus* 52,9% (9 spesies ikan), *Lemna minor* 52,9% (9 spesies ikan), *Nelumbo nucifera* 52,9% (9 spesies ikan), *Utricularia aurea* 52,9% (9 spesies ikan), *Crinum asiaticum* 52,9% (9 spesies ikan), *Diplazium esculentum* 47,1% (7 spesies ikan), *Hymenachne amplexicaulis* 47,1% (8 spesies ikan), *Ipomoea aquatica* 47,1% (8 spesies ikan), *Nymphaea alba* 47,1% (8 spesies ikan), *Salvinia natans* 47,1% (8 spesies ikan), *Stenochlaena palustris* 47,1% (8 spesies ikan), *Phaspalum conjugatum* 47,1% (8 spesies ikan), *Bulbostylis juncoides* 41,2% (7 spesies ikan), *Limnocharis flava* 35,6% (6 spesies ikan), *Salvinia molesta* 35,3% (6 spesies ikan), *Hydrocharis Morsus* 29,4% (5 spesies ikan), *Neptunia oleracea* 29,4% (5 ikan), *Salvinia minima* 29,4% (5 ikan), *Caladium sp*. 23,5% (4 ikan), *Azolla pinnata* 17,6% (3 spesies ikan), *Lemna perpusilla* 17,6% (3 spesies ikan), *Bulbostylis barbata* 17,6% (3 spesies ikan), *Nymphaea lotus* 11,8% (2 spesies ikan). Sedangkan tumbuhan yang paling sedikit dimanfaatkan oleh ikan untuk bertelur dan membesarkan anak adalah tumbuhan *Hydrilla verticillata* yaitu sebesar 5.9% (1 spesies ikan). Hal tersebut menunjukkan, bahwa spesies tumbuhan rawa menentukan jenis-jenis ikan air tawar untuk bertelur dan memelihara anak.



Keterangan :

1. *Eichornia crassipes*
2. *Pistia stratoites*
3. *Cyperus digitatus*
4. *Lemna minor*
5. *Nelumbo nucifera*
6. *Utricularia aurea*
7. *Crinum asiaticum*
8. *Diplazium esculentum*
9. *Hymenachne amplexicaulis*
10. *Ipomoea aquatica*
11. *Nymphaea alba*
12. *Salvinia natans*
13. *Stenochlaena palustris*
14. *Phaspalum conjugatum*
15. *Bulbostylis barbata*
16. *Limnocharis flava*
17. *Salvinia molesta*
18. *Hydrocharis Morsus*
19. *Neptunia oleracea*
20. *Salvinia minima*
21. *Caladium sp.*
22. *Azolla pinnata*
23. *Lemna perpusilla*
24. *Bulbostylis juncoides*
25. *Nymphaea lotus* L
26. *Hydrilla verticillata*

Gambar 3. Tumbuhan Rawa yang Berpotensi Sebagai Niche Ikan Rawa (%)

Berdasarkan hasil penelitian, ciri morfologi tumbuhan air yang dimanfaatkan ikan sebagai relung untuk bertelur dan membesarkan anak adalah ciri morfologi daun dan akar tumbuhan tersebut. Jenis tumbuhan Eichornia crassipes merupakan tumbuhan air dengan relung terluas untuk berbagai jenis ikan rawa. Sebagai gambaran, berikut disajikan bagaimana ciri-ciri tumbuhan Eichornia crassipes sebagai tumbuhan yang paling disukai ikan untuk bertelur dan beternak

ikan muda. *Eichornia crassipes* adalah tumbuhan berhabitus herba makrofit atau tumbuhan yang sepanjang hidupnya mengapung di atas air. Tumbuhan ini memiliki helai daun yang tersusun dalam bentuk roset, berbentuk bulat telur lebar yang sangat menguntungkan ikan untuk menempelkan telur bagi ikan yang meletakkan telurnya pada permukaan datar. Selain itu helaian daun yang lebar akan melindungi telur dan anak ikan dari efek sinar matahari langsung. Sistem perakaran eceng gondok adalah serabut dengan banyak akar-akar kecil yang subur dan lebat akan menjadi tempat yang sesuai bagi ikan yang peletakan telurnya diantara akar-akar kecil tersebut. Selain itu akar-akar kecil yang subur dan lebat banyak ditemukan bahan-bahan organik dan anorganik yang dibutuhkan sebagai sumber makanan bagi anak ikan. Warna akar yang hitam akan melindungi telur dan anak-anak ikan dari bahaya predator. Karakteristik morfologi yang seperti itulah yang menyebabkan tumbuhan ini paling disukai oleh ikan air tawar untuk bertelur dan memelihara anaknya. Dalam penelitian ini semua ikan yang ditemukan sebanyak 17 spesies air tawar yang hidup di rawa bertelur, dan memelihara anaknya pada *Eichornia crassipes.* Hasil penelitian lain yang juga menemukan *Eichornia crassipes* sebagai niche ikan untuk melakukan reproduksi dilakukan oleh Whetstone (2009), Gettys (2009) dan Ismail, *et.al.* (2018).

Pistia stratoites memiliki daun memiliki macam daun tunggal. dengan tata letak daun roset akar yang lebat dan rapat, bentuk daun bangun sudip, tepi daun berlekuk, dengan permukaan daun halus bergaris-garis berambut, testur daun tebal dan lembut dengan panjang 1,3-10 cm dengan lebar 1,5-6 cm. Morfologi daun yang demikian sangat menguntungkan ikan untuk menempelkan atau meletakkan telur. Selain itu helaian daun yang berkumpul atau roset akan melindungi telur dan anak ikan dari efek sinar matahari maupun arus atau gelombang air. Akar tumbuhan ini masuk di dalam dasar air, sehingga tidak dapat dimanfaatkan oleh ikan untuk menempelkan atau meletakkan telur. Sementara itu pada *Hydrilla verticillate* hanya ditemukan ikan *Rasbora argyrotaenia* yang menggunakan tumbuhan tersebut sebagai tempat bertelur dan membesarkan anaknya. *Hydrilla verti*cillata merupakan berhabitus herba yang hidup di air menjalar rapat, dengan batang memiliki interkalar 0,7 cm-1,4 cm bercabang yang terdapat daun tunggal, dengan tata letak dalam lingkaran yang berjumlah 3-6 daun yang berbentuk daun lanset, tepi daun bergerigi, permukaan daun dengan panjang 0.6-2,5 cm dan lebar 1,2-5,5 cm. Sistem perakaran tumbuhan ini adalah serabut menancap di dasar air. Berdasarkan karakteristik morfologi tersebut, maka potensi tumbuhan sebagai niche untuk bertelur dan membesarkan anak hanya pada daun. Selain itu dengan habitusnya yang rapat, akan menjadi hambatan bagi ikan-ikan berukuran menengah dan besar untuk keperluan reproduksi tersebut. Sehingga hanya ikan yang berukuran kecil yang dapat memanfaatkan tumbuhan tersebut untuk bertelur, dan membesarkan anak yang dalam penelitian ini adalah *Rasbora argyrotaenia.* Hasil penelitian lain yang juga menemukan *Hydrilla verticillate* sebagai niche ikan dilaporkan oleh Ismail, *et.al*. (2018).

Berdasarkan uraian di atas, maka ciri morfologi bentuk, ukuran, jumlah dan daun yang mengapung dipermukaan, bentuk dan jumlah serabut akar yang mengapung di air paling banyak digunakan oleh ikan air tawar untuk bertelur dan memelihara benihnya. Semakin besar ukuran daun dan jumlah daun yang menutupi permukaan air, semakin kasar permukaan dan tepi daun, semakin rapat sistem akar serabut tumbuhan di dalam air (bukan di dalam tanah), semakin banyak ikan memilih tumbuhan tersebut untuk bertelur dan membesarkan anak. Selain itu, morfologi daun yang lebar dan melimpah akan memperlambat aliran air oleh arus, perairan di sekitarnya menjadi tenang, sehingga efektif untuk bertelur dan beternak ikan. Rimpang dan akar yang padat di dalam air dapat menahan dan mengikat mineral dan bahan organik yang dibutuhkan oleh ikan muda untuk tumbuh. Tumbuhan air yang berdaun lebar di dalam atau dipermukaan air memiliki peran penting sebagai oksidator di dalam air, sehingga sangat efisien dalam mengikat karbondioksida di dalam air dan melepaskannya menjadi oksigen yang bermanfaat bagi ikan muda. Konsep gulma di habitat rawa bila dilihat dari sudut pandang pentingnya menjaga keanekaragaman ikan sebaiknya tidak digunakan, karena habitat rawa bukan merupakan kawasan yang digunakan untuk budidaya tanaman produktif. Keberadaan tumbuhan air di habitat rawa perlu dijaga agar ikan air tawar yang dibutuhkan oleh masyarakat yang tinggal di daerah tersebut dapat selalu terjaga dan dapat dimanfaatkan sebagai sumber protein hewani alami. Seperti dilansir Triyanto dkk. (2019); Lende & Khileri (2021), menemukan bahwa ikan menggunakan tumbuhan air untuk meletakkan telur dan berkembang biak di permukaan daun tumbuhan air, di antara tumbuhan berdaun halus, dan di bawah tumbuhan air.

Oleh karena itu, jenis tumbuhan yang disukai oleh ikan ini perlu dipertahankan dan ditingkatkan kesuburannya untuk menjamin perkembangan ikan air tawar, terutama yang hidup di rawa-rawa. Hal ini perlu disebarluaskan kepada masyarakat yang tinggal di sekitar rawa melalui pendidikan atau penyuluhan tentang potensi, ancaman, dan konservasi lahan rawa, khususnya keberadaan tumbuhan air terhadap keberadaan ikan air tawar di habitat rawa. Masyarakat terbiasa membuang tanaman ini di sekitar rawa karena dianggap gulma atau mengganggu perahu mereka. Menurut Fuller et al. (1998) keterpaduan antara tutupan vegetasi dan keanekaragaman hayati lainnya seperti ikan dapat digunakan untuk membantu perencanaan konservasi.

Selain itu, kami menemukan setiap ikan yang hidup di rawa tidak pernah menggunakan satu tanaman bersama-sama untuk membesarkan anak di waktu dan tempat yang sama. Dengan demikian, satu tanaman hanya digunakan oleh satu jenis ikan dalam setiap pemijahan. Keanekaragaman jenis tumbuhan air di rawa mempengaruhi aktivitas, pertumbuhan, dan pembentukan teritorial suatu spesies ikan rawa. Seperti yang dijelaskan oleh Gause (Odum, 1993) bahwa tidak ada spesies yang sama menggunakan sumber daya yang sama pada waktu yang sama, hal ini juga berlaku untuk ikan dalam menggunakan tanaman air sebagai relung untuk bertelur, dan membesarkan anak-anaknya. Dengan demikian dapat dikatakan, bahwa ikan memilih tumbuhan tertentu sebagai tempat bertelur dan membesarkan anak-anaknya secara khusus tanpa kehadiran ikan lain untuk melakukan hal yang sama. Penelitian oleh Mouton et al. (2010) menunjukkan perbedaan dalam sejarah kehidupan atau bahkan aliran gen kumpulan ikan dapat menghasilkan relung

realisasi yang berbeda. Haller (2009); Kosta dkk. (2010); Ismail dkk. (2018) menyatakan kelimpahan tumbuhan air memicu pertumbuhan dan kondisi ikan. Keterbatasan dan kelebihan tumbuhan air di daerah rawa dapat mengurangi kelimpahan ikan. Korelasi negatif yang dapat terjadi menurut (Mirmanto, 2009) adalah adanya persaingan antar individu bibit pada awal pertumbuhan bukan antar spesies.

SIMPULAN

Berdasarkan hasil penelitian terhadap tumbuhan rawa yang berpotensi sebagai *Niche* ikan rawa di tiga kawasan rawa Kalimantan Indonesia, ditemukan 26 spesies tumbuhan air yang digunakan oleh 17 spesies ikan rawa untuk bertelur dan membesarkan anak dengan memilih tumbuhan tertentu tanpa kehadiran ikan lain untuk melakukan hal yang sama. Tumbuhan air yang dominan atau paling banyak dimanfaatkan oleh ikan yang hidup di rawa sebagai *Niche* bertelur dan pemeliharaan anak adalah *Eichornia crassipes* semua spesies ikan air tawar yang ditemukan sebanyak 17 spesies ikan, kemudian disusul oleh *Pistia stratoites* sebanyak 12 spesies ikan, *Cyperus digitatus, Lemna minor, Nelumbo nucifera, Utricularia aurea, Crinum asiaticum* masing-masing sebanyak 9 spesies ikan, *Diplazium esculentum, Hymenachne amplexicaulis, Ipomoea aquatica, Nymphaea alba, Salvinia natans, Stenochlaena palustris, Phaspalum conjugatum masin-masing* sebanyak 8 spesies ikan, *Zoysia matrella* sebanyak 7 spesies ikan, *Limnocharis flava* dan *Salvinia molesta* sebanyak 6 spesies ikan, *Hydrocharis morsus, Neptunia oleracea, Salvinia minima* maisng-masing sebanyak 5 spesies ikan, *Caladium sp*. sebanyak 4 ikan, *Azolla pinnata, Lemna perpusilla, Megathyrsus maximus* masing-masing sebanyak 3 spesies ikan), dan *Nymphaea lotus* sebanyak 2 spesies ikan.

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COVERING LETTER

Dear **Editor-in-Chief,**

I herewith enclosed a research article,

Title:

Exploration of aquatic plants as a niche (lay eggs and keep its fry) for freshwater fish in swamp habitat in South Kalimantan, Indonesia

Author(s) name:

Dharmono; Mahrudin; Riya Irianti; Hery Fajeriadi

Address

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Study Program of Biology Education, Faculty of Teacher Training and Education Science, University of Lambung Mangkurat, Jl. Brigjend. H. Hasan Basry, Banjarmasin 70126, South Kalimantan, Indonesia.

For possibility publication on the journal:

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Biodiversitas

Novelty:

(state your claimed novelty of the findings versus current knowledge)

The plant species *Eichornia crassipes* is an aquatic plant with the widest niche for various types of swamp fish. We found every fish that lived in the swamp never used one plant together to raise young at the same time and place. Thus, one plant is only used by one type of fish in each spawning. The diversity of aquatic plant species in swamps affects the activity, growth, and territorial formation of a species of swamp fish.

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This manuscript has not been published and is not under consideration for publication to any other journal or any other type of publication (including web hosting) either by me or any of my co-authors.
Author(s) has been read and agree to the Ethical Guidelines.

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Place and date:

Banjarmasin, 18 November 2021

Sincerely yours,

(fill in your name, no need scanned autograph)

Dr. Dharmono, M.Si.

Exploration of aquatic plants as a niche (lay eggs and keep its fry) for freshwater fish in swamp habitat in South Kalimantan, Indonesia

DHARMONO[1,♥], MAHRUDIN[2], RIYA IRIANTI[2], HERY FAJERIADI[1]

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Manuscript received: DD MM 2016 (Date of abstract/manuscript submission). Revision accepted: ..... 2016. (8 pt)

Abstract. Around 208.893 ha of the total area of South Kalimantan is the swamp. The swamp vegetation lives in symbiosis with the animals around it. Many studies have examined the two separately, but specific interactions between aquatic animals and marsh plant species are rarely observed here. Aquatic animals such as fish are very dependent on the presence of plants that live in swamps as niches or microhabitats, especially for shelter and breeding. This study aimed to explore swamp plants used as freshwater fish niches to lay eggs and raise young. The research method used is descriptive quantitative research. The study population was all plants found in three swamp habitats in South Kalimantan, Indonesia, namely the swamps of the North Hulu Sungai Regency, the swamps of the Tanah Laut Regency, and the swamps of the Barito Kuala Regency. The research sample was determined by purposive random sampling in each swamp to the types of plants found in fish eggs and chicks. The research data were analyzed descriptively. The study results found 26 species of plants used by 17 species of swamp fish as niches in laying eggs and raising young. Therefore, the types of plants favored by fish need to be maintained. Their fertility increased to ensure the breeding of freshwater fish and need to be disseminated to the public through education or counseling about the potential, threats, and conservation of swamps, especially the presence of aquatic plants on the presence of freshwater fish in swamp habitats.

Keywords: Swamp plants, a place to stand and raise young fish

Running title: Hydrophyte as niche freshwater's fish

INTRODUCTION

The definition of a swamp based on the 1971 Ramsar Convention is an area that is almost always waterlogged throughout the year, naturally formed on relatively flat or sunken land with mineral deposits or peat and overgrown with vegetation (Matthews, 2013). Swamps are waterlogged, acidic, anoxic, and oligotrophic ecosystems (Too et al., 2021). Swamps are distributed in ecosystems as floodplain areas (Phiri et al., 2021), seed banks (Lei & Middleton, 2021), the transition of water between land and atmosphere (Ohkubo et al., 2021), and aquatic plants used as media for cultivation. organisms and kinetic studies (Padil et al., 2021). In the last decade, swamp ecosystems have experienced many phenomena, such as swamp forest fires, which occur more frequently in the dry season (Kubik et al., 2020), caused by changes in the environment and climate (Lei & Middleton, 2021), thus affecting the carbon cycle of the swamp ecosystem. (Liu et al., 2020), and swamp animal populations are decreasing due to reduced niches (Paul et al., 2020).

The largest swamp in South Kalimantan is the lebak swamp, either seasonally or permanently. The lebak swampland area in South Kalimantan is about 208.893 ha, with vegetation dominated by shrubs and shrubs. Swamp forest vegetation can adapt to anaerobic areas and are flooded seasonally or permanently. Whetstone (2009) states that swamp plant vegetation based on its presence in water is grouped into three groups, namely surface plants, floating plants, and submerged plants. Surface plants have roots at the bottom of the water with leaves extending upward to the water's surface, for example, *Sagittaria Sinensis* and *Phragmites communis*.

Meanwhile, Goel (2006) stated that floating plants are plants whose roots hang in the water or do not touch the bottom of the water, for example, *Nymphaea* sp. and *Nelumbo* sp. Submerged plants are plants that live entirely in water, such as *Hydrilla verticillate*, *Najas minor*, *Chara Vulgaris*, and *Ceratophyllum demersum*. The research results conducted by Djufri et al. (2016) found 41 species of herbaceous plants in the Tripa peat swamp forest, Indonesia.

The peat swamp ecosystem is one of the essential areas and is a habitat that has high species endemism (Joni et al., 2015). Different vegetation in this ecosystem zoning indicates niche formation. However, small-scale spatial variations indicate the stochastic nature of the vegetation (DiMichele et al., 2017). Bitter-fruited and sweet-fruited vegetation can also form different ecological niches (Vihotogbé et al., 2019). Niche area and trophic diversity can indicate resource use according to trophic availability, regardless of size or gender (Correia, 2002). Ridge-hollow swamps can generate ecological niche/niche skeletons in strongly acidic aqueous media (Rybina et al., 2014), predicting what aquatic plants and

aquatic animals may live in the area. Ndehedehe et al. (2020) stated that the management of aquatic habitats could support the maintenance of aquatic biodiversity. According to Barletta et al. (2010), continued habitat loss could result in biodiversity loss before known full species diversity. According to Kłosowski & Jabłońska (2009), in addition to the wide variability, habitat conditions in water bodies are distinguished based on the dominance of aquatic plant species associated with particular habitats.

Aquatic plants in swamp vegetation habitats play an essential role for fish life (Kurniawan & Paramita, 2019). Aquatic animals such as fish are very dependent on the presence of plants that live in swamps as a niche or micro-habitat, especially for shelter and breeding (Raharjo, 2018). Niche signifies the place of animals in their biotic and abiotic environment related to food and their enemies. In other words, niche describes the status of animals in their community to show what they do. The abundance of aquatic plants is positively correlated with fish populations (Odum, 1993). Habitats with moderate amounts of aquatic plants provide an optimal environment for many fish to increase fish diversity, feeding, growth, and reproduction.

On the other hand, limited and excessive vegetation can reduce the growth rate of fish by 75% to 85% of the coverage of the plant community (Ismail et al., 2018). Fish uses aquatic plants to lay eggs on the leaf surface of aquatic plants or among smooth-leaved plants on mangrove vegetation (Triyanto et al., 2019). For example, the parent fish *Chlaria batracus* and fish *Melanotaenia* sp. usually form pairs, lay eggs, and protect eggs and seeds from harm under aquatic plants (Lende & Khileri, 2021).

Each type of plant has specific morphological characteristics to adapt to its habitat (Steenis, 2013). These morphological characteristics are thought to be used by freshwater fish species as living and growing habitats. Based on the research results of Ismail et al. (2018) and other scientific journals, no research results have been found that report certain types of plants selected by certain types of fish as a niche for laying eggs and raising their young. In addition, the types of plants favored by fish need to be maintained, and their fertility needs to be increased. This aims to ensure the breeding of freshwater fish. This contribution needs to be disseminated to the people living around the swamps through education or counseling about the potential, threats, and conservation of swamps, especially the presence of aquatic plants on the presence of freshwater fish in swamp habitats, and even deliberately planted so that there are more fish. Therefore, this study aims to explore the types of swamp plants that are "chosen" by freshwater fish as niches for laying eggs and maintaining their seeds.

MATERIALS AND METHODS

This research was carried out in three swamp habitats in South Kalimantan, Indonesia, where freshwater fish are found: Rawa Hulu Sungai Selatan Regency, Rawa Tanah Laut Regency, and Barito Kuala Regency in April 2021. The type of research used is descriptive research with observational techniques. The area of observation swamps in the North Hulu Sungai Regency is 92.5 Ha, the Tanah Laut Regency Swamp is 56.7 Ha, and the Barito Kuala Regency Swamp is 47.2 Ha (Figure 1). The research sample was determined by purposive random sampling in each swamp by observing and documenting the types of plants found in fish eggs and chicks as data for the niche of swamp fish to lay eggs and raise offspring. Determination of plant species using a plant observation guide. Determination of the type of plant "chosen" by fish as a niche in laying eggs and raising young is based on finding eggs, fish fry, and mother fish around the plants. Determination of the type of parent fish using a fish observation guide. The research data were analyzed descriptively.

Figure 1 Location of research

RESULTS AND DISCUSSION

The results of the research show that swamp plants have potential as niches. This is based on discovering eggs, juveniles, and broodstock of swamp fish around swamp plants in three swamp areas of Kalimantan, Indonesia. There are 26 types of aquatic plants used by 17 species of swamp fish to lay eggs and raise offspring, as shown in Table 1. This study also indicates that aquatic plants were used as fish niches more than the research conducted by Ismail et al. (2018). Ismail et al. (2018) found eight plant species: *Lemna Minor*, *Polygonum barbatum*, *Eichhornia crassipes*, *Pistia stratiotes*, *Neptunia oleracea*, *Hydrilla verticillata*, *Salvinia molesta*, *Phragmites australis*, and *Azolla pinnata*. However, this study's results did not specifically explain what freshwater fish species most favored plants.

Tabel 1 Swamp Plants Potential as Swamp Fish Niche

No.	Plant Species	Fish Species																
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**
1	*Azolla pinnata*		F													F	F	
2	*Caladium* sp.		F							F						F		F
3	*Cyperus digitatus*		E	E	F	E				F			F			F	F	F
4	*Diplazium esculentum*	F	E	E				F						F		F		F
5	*Phaspalum conjugatum*	F		E	F	E		F		F				F			F	
6	*Eichornia crassipes*	F	E	E	F	F	E	F	F	F	E	F	F	F	F	F	F	E
7	*Hydrilla verticillata*														F			
8	*Hydrocharis Morsus*	F						F						F		F		F
9	*Hymenachne amplexicaulis*	F	E	E		E		F						F		F		E
10	*Ipomoea aquatica*		E	F	F				F	F		F			E		F	
11	*Lemna Minor*		E	E	F	E					E	F			F	F		E
12	*Lemna perpusilla*														F	F		E
13	*Limnocharis flava*	F						F						F		F	F	F
14	*Megathyrsus maximus*				F	F				F								
15	*Nelumbo nucifera*		F	E	F	E	E					F				F	F	F
16	*Neptunia oleracea*			F			F		F							F		E
17	*Nymphaea alba*		F	E	F						F		E		F	F		E
18	*Nymphaea lotus* L.															F		E
19	*Pistia stratoites*	F	E	F	F	E		F	F			F		F		F	F	F
20	*Salvinia minima*		E	F					F							F		F
21	*Salvinia molesta*									F		F			E	F	F	E
22	*Salvinia natans*		E	E		E			F	F						F	F	E
23	*Stenochlaena palustris*	F						F		F			F	F		F	F	F
24	*Utricularia aurea*	F	E	E	F	E		F						F		F		F
25	*Zoysia matrella*	F		F				F	F					F		F		E
26	*Crinum asiaticum*		E		F				F			F	F	F	E		F	E

Notes: E = eggs, F = fry

A	*Channa striata*	G	*Channa micropeltes*	M	*Channa lucius*
B	*Anabas testudineus*	H	*Cyprinus carpio*	N	*Rasbora argyrotaenia*
C	*Trichogaster trichopterus*	I	*Pampus argenteus*	O	*Mystus Scopoli*
D	*Rasbora dusonensis*	J	*Clarias batrachus*	P	*Osteochilus hasselti*
E	*Trichogaster pectoralis*	K	*Criptopterus spp*	Q	*Oxyeleotris marmorata*
F	*Helestoma temminkii*	L	*Hemibagrus nemurus*		

Based on research conducted in April 2021, it can be seen that the presence of fish in swamp plants has two forms, namely still in the form of eggs, which are indicated by the presence of foam around the plants and in the form of tillers (Table 1 and Figure 2). This shows that the reproduction period of freshwater fish is different or not at the same time. Setyaningrum and Wibowo (2017) reported the reproductive ability of 5 fish species (*Cyprinus carpio, Barbonymus gonionatus, Osteochillus vittatus Oreochromis niloticus,* and *Clarias gariepinus*) shows differences. Devkota & Kathayat (2020) explained that climate change greatly affects the reproduction, development, structure, and abundance of freshwater fish populations. In addition, the reproductive potential of fish depends on the development of the gonads until the fish spawn and produce seeds. Based on information from the people living in the three swamp areas studied, the breeding season for fish in the area indicated by the presence of fish eggs and chicks is from February to August.

Figure 2 The presence of haruan fish eggs and chicks in aquatic plants

Niche signifies an animal's place in its biotic and abiotic environment in relation to food and its enemies or indicates what it does (Odum, 1993). Based on this concept and Figure 3, it can be seen that the dominant or most widely used aquatic plant by fish that live in swamps as a niche for laying eggs and rearing young is *Eichornia crassipes* with 100% of all freshwater fish species found (17 fish species), then followed by by *Pistia stratoites* by 70.6% (12 fish species), *Cyperus digitatus* 52.9% (9 fish species), *Lemna Minor* 52.9% (9 fish species), *Nelumbo nucifera* 52.9% (9 fish species), *Utricularia aurea* 52.9% (9 fish species), *Crinum asiaticum* 52.9% (9 fish species), *Diplazium esculentum* 47.1% (7 fish species), *Hymenachne amplexicaulis* 47.1% (8 fish species), *Ipomoea aquatica* 47.1% (8 fish species), *Nymphaea alba* 47.1% (8 fish species), *Salvinia natans* 47.1% (8 fish species), *Stenochlaena palustris* 47.1% (8 fish species), *Phaspalum conjugatum* 47, 1% (8 fish species), *Bulbostylis juncoides* 41.2% (7 fish species), *Limnocharis flava* 35.6% (6 fish species), *Salvinia molesta* 35.3% (6 species fish), *Hydrocharis Morsus* 29.4% (5 fish species), *Neptunia oleracea* 29.4% (5 fish), *Salvinia minima* 29.4% (5 fish), *Caladium* sp. 23.5% (4 fish), *Azolla pinnata* 17.6% (3 fish species), *Lemna perpusilla* 17.6% (3 fish species), *Bulbostylis barbata* 17.6% (3 fish species), *Nymphaea lotus* 11.8 % (2 fish species). Meanwhile, the plant least used by fish for laying eggs and raising children is *Hydrilla verticillata*, which is 5.9% (1 species of fish). This shows that swamp plant species determine the types of freshwater fish to lay eggs and raise young.

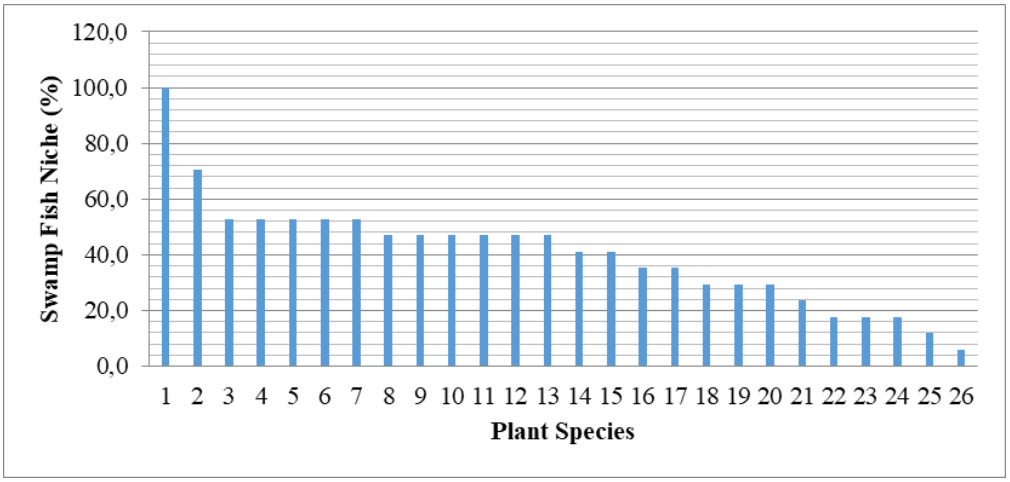

Figure 3 Swamp Plants Potential as Swamp Fish Niche (%)

Notes:

1. *Eichornia crassipes*
2. *Pistia stratoites*
3. *Cyperus digitatus*
4. *Lemna Minor*
5. *Nelumbo nucifera*
6. *Utricularia aurea*
7. *Crinum asiaticum*
8. *Diplazium esculentum*
9. *Hymenachne amplexicaulis*
10. *Ipomoea aquatica*
11. *Nymphaea alba*
12. *Salvinia natans*
13. *Stenochlaena palustris*
14. *Phaspalum conjugatum*
15. *Zoysia matrella*
16. *Limnocharis flava*
17. *Salvinia molesta*
18. *Hydrocharis Morsus*
19. *Neptunia oleracea*
20. *Salvinia minima*
21. *Caladium sp.*
22. *Azolla pinnata*
23. *Lemna perpusilla*
24. *Megathyrsus maximus*
25. *Nymphaea lotus* L
26. *Hydrilla verticillata*

Based on the study results, the morphological characteristics of aquatic plants used by fish as niches for laying eggs and raising young are the morphological characteristics of the leaves and roots of these plants. The plant species *Eichornia crassipes* is an aquatic plant with the widest niche for various types of swamp fish. As an illustration, the following describes the characteristics of the *Eichornia crassipes* plant as the most preferred plant for fish to lay eggs and raise young fish. *Eichornia crassipes* is a herbaceous plant with macrophytes or plants that float on water throughout their lives. This plant has leaves arranged in a rosette, wide ovoid shape, which is very beneficial for fish to attach eggs to fish that lay their eggs on a flat surface. In addition, the wide leaf blades will protect the eggs and chicks from the effects of direct sunlight. The water hyacinth root system is fibrous with many small, fertile, and dense roots that will be suitable for fish laying eggs between these small roots. In addition, small, fertile, and dense roots are found in an abundance of organic and inorganic materials needed as food sources for young fish. The black color of the roots will protect the eggs and young fish from predators. Such morphological characteristics make this plant the most preferred by freshwater fish to lay eggs and raise their young. In this study, all the fish found were 17 freshwater species that live in the spawning swamp and raise their young in *Eichornia crassipes*. The results of other studies that also found *Eichornia crassipes* as a fish niche for reproduction were carried out by Whetstone (2009), Gettys (2009), and Ismail et al. (2018).

Pistia stratoites have a single leaf type with a leaf arrangement of dense and dense root rosettes, the shape of the leaves in the shape of a spoon, the edges of the leaves are grooved, with a smooth leaf surface with hairy stripes, the texture of the leaves is thick and soft with a length of 1.3-10 cm and a width of 1.5-6 cm. Such leaf morphology is very beneficial for fish to attach or lay eggs. In addition, the gathered leaf blades or rosettes will protect the eggs and chicks from the effects of sunlight and currents or water waves. The roots of this plant enter the bottom of the water, so fish cannot use it to attach or lay eggs. Meanwhile, only *Rasbora argyrotaenia* was found in Hydrilla verticillate, which uses this plant to lay eggs and raise their young. *Hydrilla verticillata* is a herbaceous habit that lives in tightly spreading water. It has stems having intercalated 0.7 cm-1.4 cm branched with single leaves, with a circular layout of 3-6 leaves that are lanceolate in shape, leaf margins are serrated, leaf surface with a length of 0.6-2.5 cm and a width of 1.2-5.5 cm. The root system of this plant is the fibers stuck to the bottom of the water. Based on these morphological characteristics, the potential of plants as a niche for laying eggs and raising young is only in leaves. In addition, with a dense habitus, it will be an obstacle for medium and large-sized fish for their reproductive purposes. So that only small fish can use these plants to lay eggs and raise children, which in this study is *Rasbora argyrotaenia*. The results of another study which also found *Hydrilla verticillate* as a fish niche, were reported by Ismail et al. (2018).

Based on the description above, the morphological characteristics of shape, size, number, and leaves that float on the surface, shape, and number of root fibers that float in water are used mainly by freshwater fish to lay eggs and maintain their seeds. The larger the leaf size and the number of leaves that cover the water surface, the rougher the leaf surface and edges, the denser the root system of plant fibers in the water (not in the soil), the more fish choose these plants to lay eggs and raise young. In addition, the wide and abundant leaf morphology will slow the flow of water by currents, the surrounding waters become calm, making it effective for laying eggs and raising fish. Rhizomes and dense roots in the water can hold and bind the minerals, and young fish need to grow organic matter. Aquatic plants with broad leaves in or on the surface of the water have an important role as oxidizing agents in the water, so they are very efficient in binding carbon dioxide in the water and releasing it into oxygen which is beneficial for young fish. The concept of weeds in swamp habitat, when viewed from the point of view of the importance of maintaining fish diversity, should not be used because swamp habitat is not an area used for productive plant cultivation. The existence of aquatic plants in the swamp habitat needs to be maintained so that the freshwater fish required by the people living in the area can always be maintained and used as a source of natural animal protein. As reported by Triyanto et al. (2019); Lende & Khileri (2021), found that fish use aquatic plants to lay eggs and reproduce on the leaf surface of aquatic plants, among smooth-leaved plants and under aquatic plants.

Therefore, the types of plants found by these fish need to be maintained, and their fertility increased to ensure the development of freshwater fish, especially those that live in swamps. This needs to be disseminated to the people living around the swamps through education or counseling about the potential threats and conservation of swampland, especially the presence of aquatic plants on the presence of freshwater fish in the swamp habitat. People are used to throwing this plant around the swamp because it is considered a weed or disturbing their boats. According to Fuller et al. (1998), integrating vegetation cover and other biodiversity such as fish can assist conservation planning.

In addition, we found that every fish that lived in the swamp never used one plant together to raise young at the same time and place. Thus, one plant is only used by one type of fish in each spawning. The diversity of aquatic plant species in swamps affects swamp fish species' activity, growth, and territorial formation. As Gause (Odum, 1993) explains that no two species use the same resources simultaneously, this is also true for fish using aquatic plants as niches to lay eggs and raise their young. Thus it can be said that fish choose certain plants to lay their eggs and raise their young precisely without the presence of other fish to do the same. Research by Mouton et al. (2010) shows that differences in life histories or even gene flow of fish assemblages can result in different realization niches. Haller (2009), Costa et al. (2010), Ismail et al. (2018) stated that the abundance of aquatic plants triggers the growth and condition of fish. The limitations and excess of aquatic plants in swamp areas can reduce the abundance of fish. According to (Mirmanto 2009), the negative correlation is the existence of competition between individual seeds at the beginning of growth, not between species.

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• Running titles	Hydrophyte as niche freshwater's fish
• All figure captions	**Figure 1** Location of research **Figure 2** the presence of freshwater's fish and eggs in plants
• All tables (incl title and note/description)	**Tabel 1** Swamp Plants Potential as Swamp Fish Niche Notes: T = Telur (eggs), A = Anakan (fry)

Further considerations	
• The manuscript has been "spell & grammar-checked" Better if it is revised by a professional science editor or a native English speaker.	
• References are in the correct format for this journal.	
• All references mentioned in the Reference list are cited in the text, and vice versa.	
• Colored figures are only used if the information in the text may be losing without those images.	
• Charts (graphs and diagrams) are drawn in black and white images; use shading to differentiate.	

Aquatic plants as niche for lay eggs and raising juveniles by freshwater fish in three swamp habitats in South Kalimantan, Indonesia

Abstract. Swamp is as an area that is almost always waterlogged throughout the year, making it very unique ecosystem. There is a wide variety of ecosystem services provided by swamp ecosystem, one of those is habitat of freshwater fish which is related to the presence of swamp vegetation. This study aimed to investigate swamp plants used as niches for freshwater fish to lay eggs and raise its offspring in three swamp areas in three regencies (i.e., Hulu Sungai Utara Regency, Tanah Laut Regency and Barito Kuala Regency) in South Kalimantan Province, Indonesia. Purposive random sampling was conducted in each swamp by observing and documenting the types of plants where fish eggs and offspring found. We recorded 26 species of aquatic plants used by 17 species of swamp fish to lay eggs and raise offspring/fry. *Eichornia crassipes* was the most widely used aquatic plant species with 100% of all freshwater fish species found (17 fish species), followed by *Pistia stratoites* by 70.6% (12 fish species) and *Cyperus digitatus*, *Lemna minor*, *Nelumbo nucifera*, *Utricularia aurea* and *Crinum asiaticum* with each used by 52.9% (9 fish species). These plant species favored by fish need to be maintained and controlled to support the population of the fish.

Keywords: Swamp plants, a place to stand and raise young fish

Running title: Exploration of aquatic plants as a niche for freshwater fish

INTRODUCTION

Based on the 1971 Ramsar Convention, swamp is defined as an area that is almost always waterlogged throughout the year, naturally formed on relatively flat or sunken land with mineral deposits or peat and overgrown with vegetation (Matthews, 2013). Swamps are waterlogged, acidic, anoxic, and oligotrophic ecosystems (Too et al., 2021). Swamps ecosystems as floodplain areas provide a wide variety of ecosystem services (Phiri et al., 2021), including and maintaining hydrological and carbon cycles between land and atmosphere (Ohkubo et al., 2021), medium of seeds distribution (Lei & Middleton, 2021), and the habitat of aquatic plants and animals (Padil et al., 2021). For example, a study in the Tripa peat swamp forest, Indonesia recorded 41 species of herbaceous plants (Djufri et al., 2016).

Despite their importance, in the last decades, swamp ecosystems, particularly in the tropics, have been pressured by various human activities such as logging, deforestation and degradation, and land conversion, making it prone to large fires especially during the dry season (Kubik et al., 2020). This phenomenon causes changes in the environment and climate (Lei & Middleton, 2021), thus affecting the carbon cycle of the swamp ecosystem (Liu et al., 2020) and threatening its biodiversity including the vegetation (Paul et al., 2020). The continuing habitat loss could result in biodiversity loss before known full species diversity (Barletta et al., 2010). Therefore, prudent management of aquatic habitats including swamp ecosystem is needed to conserve aquatic biodiversity (Ndehedehe et al., 2020)

Peat swamp ecosystem is one of the unique habitats that has high species endemism (Joni et al., 2015). Different vegetation in this ecosystem indicates niche formation due to unique biotic and abiotic factors which is mainly caused by the waterlogged condition and highly acidic water and soils. However, small-scale spatial variations show the stochastic nature of the vegetation (DiMichele et al., 2017). Niche area and trophic diversity can indicate resource use according to trophic availability, regardless of size or gender (Correia, 2002). For instance, ridge-hollow swamps can generate ecological niche in strongly acidic aqueous media with specific aquatic plants and animals that may live in the area (Rybina et al., 2014). According to Kłosowski & Jabłońska (2009), habitat conditions in water bodies are distinguished based on the dominance of aquatic plant species associated with particular habitats. For example, bitter-fruited and sweet-fruited vegetation might require different ecological niches (Vihotogbé et al., 2019).

Whetstone (2009) states that vegetation occurring in swamp ecosystem can be classified into three groups, namely surface plants, floating plants, and submerged plants. Surface plants have roots at the bottom of the water with leaves extending upward to the water surface, for example, *Sagittaria sinensis* and *Phragmites communis*. Meanwhile, Goel (2006) stated that floating plants are plants whose roots hang in the water or do not touch the bottom of the water, for

example, *Nymphaea* sp. and *Nelumbo* sp. Submerged plants are plants that live entirely in water, such as *Hydrilla verticillate*, *Najas minor*, *Chara vulgaris* and *Ceratophyllum demersum*.

Aquatic plants in swamp ecosystem play an essential role for fish life (Kurniawan & Paramita, 2019). Aquatic animals such as fish are very dependent on the presence of plants that live in swamps as a niche or micro-habitat, especially for shelter and breeding (Raharjo, 2018). The abundance of aquatic plants is positively correlated with fish populations (Odum, 1993). Habitats with moderate amounts of aquatic plants provide an optimal environment for many fish to increase fish diversity, feeding, growth, and reproduction. In contrast, limited or excessive vegetation cover can reduce the growth rate of fish by 75% to 85% (Ismail et al., 2018). Fish uses aquatic plants to lay eggs on the leaf surface of aquatic plants or among smooth-leaved plants on mangrove vegetation (Triyanto et al., 2019). For example, the parent fish *Chlaria batracus* and fish *Melanotaenia* sp. usually form pairs, lay eggs, and protect eggs and seeds from harm under aquatic plants (Lende & Khileri, 2021).

Each type of plant has specific morphological characteristics to adapt to its habitat (Steenis, 2013). In swamp ecosystem, the morphological characteristics of swamp vegetation are thought to be used by freshwater fish species as living and growing habitats. Based on the research results of Ismail et al. (2018), no research results have been found that report certain types of plants selected by certain types of fish as a niche for laying eggs and raising its offspring. In addition, the types of plants favored by fish need to be maintained, and their fertility needs to be increased.

This study aimed to investigate swamp plants used as niches for freshwater fish to lay eggs and raise its offspring in three swamp areas in South Kalimantan Province, Indonesia. The swamps in South Kalimantan, or locally called *lebak*, provide excellent context of study since the province has swamp area of 208.893 ha with vegetation dominated by shrubs and shrubs. We expect the results of this study can be disseminated to the people living around the swamps through raising awareness about the potential uses, threats, and conservation of swamps, especially the influence of aquatic plants on the presence of freshwater fish in swamp habitats, and even deliberately restore the degraded swamp to increase fish population.

MATERIALS AND METHODS

Study area and period

This research was carried out in three swamp habitats in South Kalimantan, Indonesia, namely Rawa Hulu Sungai Utara Regency, Rawa Tanah Laut Regency, and Barito Kuala Regency in April 2021. The area of swamps being observed in the Hulu Sungai Utara Regency was 92.5 Ha, the Tanah Laut Regency Swamp was 56.7 Ha, and the Barito Kuala Regency Swamp was 47.2 Ha (Figure 1).

PLEASE ADD HERE THE GENERAL DESCRIPTION OF THE THREE STUDIED AREA, INCLUDING THE VILLAGE/SUB-DISTRICT NAME (I NOTE IN THE MAP THAT YOU PROVIDED VILLAGE/SUB-DISDTRICT NAME), GEOGRAPHICAL COORDINATES, ELEVATION, TEMPERATURE, HUMIDITY, ANNUAL RAINFALL AND THE VEGETATION CONDITION OF EACH STUDY SITE.

Tempat Penelitian di Kabupaten Hulu Sungai Utara terletak di titik koordinat 2°36'17,10" Lintang Selatan dan 115°5'54,59" Bujur Timur pada ketinggian 15-17 mdpl dengan suhu berkisar antara 21-35ºC dan curah hujan 384,5 mm. Luas rawa yang diteliti adalah 92.5 ha berupa rawa lebak yang dipengaruhi oleh pasang surut air sungai dan air hujan dengan keanekaragaman flora yang didominasi oleh tumbuhan herba air berupa Hidrocharitaceae, Cyperaceae, dan Poaceae. Masyarakat yang tinggal di sekitar rawa merupakan masyarakat petani, peternak kerbau rawa dan pencari ikan. Tempat Penelitian di Kabupaten Tanah laut terletak di titik koordinat 114,583° – 114,711° Bujur Timur dan 3,56309° – 3,72364° Lintang Selatan pada ketinggian ± 0.5-1 mdpl dengan suhu berkisar antara 21-36^{0}C dan curah hujan 203,8 mm. Luas rawa yang diteliti adalah 56.7 ha berupa rawa mangrove yang dipengaruhi oleh pasang surut air laut dan air sungai dengan salinitas 0-7 ppm. Keanekaragaman flora yang didominasi oleh tumbuhan herba air berupa Mangrove, Hidrocharitaceae, Cyperaceae, dan Poaceae. Masyarakat yang tinggal di sekitar rawa merupakan masyarakat petani, nelayan dan pencari ikan. Tempat Penelitian di Kabupaten Barito Kuala terletak di titik koordinat 3°15'25" – 3°20'72" Lintang selatan dan 114°38'28" – 114°68'17" Bujur Timur pada ketinggian ± 0.5-1 mdpl dengan suhu berkisar antara 23-35^{0}C dan curah hujan rata-rata 248,23 mm/tahun. Luas rawa yang diteliti adalah 47.2 ha berupa rawa monton yang tergenang sepanjang tahun. Keanekaragaman flora yang didominasi oleh tumbuhan herba air berupa Hidrocharitaceae, Cyperaceae, Poaceae. Dan Myrtaceae. Masyarakat yang tinggal di sekitar rawa merupakan masyarakat petani, pencari kayu galam dan pencari ikan.

Data collection procedure

This research used observational techniques with descriptive analysis. The research sample was determined by purposive random sampling in each swamp by observing and documenting the types of plants where fish eggs and offspring found. Determination of plant species using a plant observation guide by Dasuki (1994, Steenis (2003) and Shui (2019) . Determination of the type of plant preferred by fish as a niche in laying eggs and raising offspring/fry is based on

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Dasuki, U.A. 1994. Sistematik Tumbuhan Tinggi. Pusat Antar Universitas Bidang Hayati. ITB Bandung.

Steenis, C. G. G. J. Van. (2003). *Flora*. Terjemahan. PT. Pradiya Paramita. Jakarta.

Shui Bie Ke, Wang Qing Feng, Guo You Hao, Haynes, R.R., Hellquist, C.B. (2019). *Hydrocharitaceae in Flora of China* @ efloras.org. http://www.efloras.org/florataxon.

the finding eggs, offspring, and mother fish around the plants. Determination of the type of parent fish using a fish observation guide by Kottelat et.al (1993), Moyle & Cech (1988), Saanin (1984). The research data were analyzed descriptively.

Figure 1. Map of three research locations in three regencies in South Kalimantan Province, Indonesia: Hulu Sungai Selatan, Tanah Laut and Barito Kuala.

RESULTS AND DISCUSSION

In our study, there were 26 species of aquatic plants used by 17 species of swamp fish to lay eggs and raise offspring/fry as shown in Table 1. The number of aquatic plants used as fish niches in this study is more than in the study conducted by Ismail et al. (2018) which only found found nine plant species, i.e., *Lemna minor*, *Polygonum barbatum*, *Eichhornia crassipes*, *Pistia stratiotes*, *Neptunia oleracea*, *Hydrilla verticillata*, *Salvinia molesta*, *Phragmites australis*, and *Azolla pinnata*.

Tabel 1. Plant species used by fish to lay eggs and raise offspring/fry in three swamps in South Kalimantan Province

No.	Plant Species	Fish Species															
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	*Azolla pinnata*		F													F	F	
2	*Caladium* sp.		F							F						F		F
3	*Cyperus digitatus*		E	E	F	E				F			F			F	F	F
4	*Diplazium esculentum*	F	E	E				F						F		F		F
5	*Phaspalum conjugatum*	F		E	F	E		F		F				F			F	
6	*Eichornia crassipes*	F	E	E	F	F	E	F	F	F	E	F	F	F	F	F	F	E
7	*Hydrilla verticillata*														F			
8	*Hydrocharis Morsus*	F						F						F		F		F
9	*Hymenachne amplexicaulis*	F	E	E		E		F						F		F		E
10	*Ipomoea aquatica*		E	F	F				F	F		F			E		F	
11	*Lemna Minor*		E	E	F	E					E	F			F	F		E
12	*Lemna perpusilla*														F	F		E
13	*Limnocharis flava*	F						F						F		F	F	F
14	*Megathyrsus maximus*				F	F				F								
15	*Nelumbo nucifera*		F	E	F	E	E					F				F	F	F
16	*Neptunia oleracea*			F			F		F							F		E
17	*Nymphaea alba*		F	E	F						F		E		F	F		E
18	*Nymphaea lotus* L.															F		E
19	*Pistia stratoites*	F	E	F	F	E		F	F			F		F		F	F	F
20	*Salvinia minima*		E	F					F							F		F
21	*Salvinia molesta*									F		F			E	F	F	E
22	*Salvinia natans*		E	E		E			F	F						F	F	E
23	*Stenochlaena palustris*	F						F		F			F	F		F	F	F
24	*Utricularia aurea*	F	E	E	F	E		F						F		F		F

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Kottelat, M., A.J. Whitten, S.N. Kartikasari & S. Wirjoatmodjo. 1993. *Fresh Water Fishes of Western Indonesia and Sulawesi*. Periplus Editions Limited, Jakarta.

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25	*Zoysia matrella*	F		F				F	F					F		F		E
26	*Crinum asiaticum*		E		F				F			F	F	F	E		F	E

Notes: E = eggs, F = fry

A	*Channa striata*	G	*Channa micropeltes*	M	*Channa lucius*
B	*Anabas testudineus*	H	*Cyprinus carpio*	N	*Rasbora argyrotaenia*
C	*Trichogaster trichopterus*	I	*Pampus argenteus*	O	*Mystus scopoli*
D	*Rasbora dusonensis*	J	*Clarias batrachus*	P	*Osteochilus hasselti*
E	*Trichogaster pectoralis*	K	*Criptopterus spp*	Q	*Oxyeleotris marmorata*
F	*Helestoma temminkii*	L	*Hemibagrus nemurus*		

Based on research conducted in April 2021, it can be seen that the presence of fish in swamp plants had two forms, namely in the form of eggs (indicated by the presence of foam around the plants) and in the form of offspring/fry (Table 1 and Figure 2). This finding suggests that the reproduction period of freshwater fish is different or happening not at the same time. This is in accordance with Setyaningrum and Wibowo (2017) who reported the reproductive ability of 5 fish species (i.e., *Cyprinus carpio, Barbonymus gonionatus, Osteochillus vittatus Oreochromis niloticus,* and *Clarias gariepinus*) which showed difference in reproduction period. Devkota & Kathayat (2020) explained that climate change greatly affects the reproduction, development, structure, and abundance of freshwater fish populations. In addition, the reproductive potential of fish depends on the development of the gonads until the fish spawn and produce seeds. Based on information from the people living in the three swamp areas studied, the breeding season for fish in the area indicated by the presence of fish eggs and offspring/fry is from February to August.

Figure 2. The presence of haruan (*Channa striata*) fish eggs and offspring in aquatic plants

Niche signifies animal habitat in its biotic and abiotic environment in relation to food and its enemies (Odum, 1993). Based on this concept and Figure 3, it can be seen that the most widely used aquatic plant by fish that live in swamps as a niche for laying eggs and rearing offspring was *Eichornia crassipes* with 100% of all freshwater fish species found (17 fish species), followed by *Pistia stratoites* by 70.6% (12 fish species), *Cyperus digitatus* 52.9% (9 fish species), *Lemna minor* 52.9% (9 fish species), *Nelumbo nucifera* 52.9% (9 fish species), *Utricularia aurea* 52.9% (9 fish species), *Crinum asiaticum* 52.9% (9 fish species), *Diplazium esculentum* 47.1% (7 fish species), *Hymenachne amplexicaulis* 47.1% (8 fish species), *Ipomoea aquatica* 47.1% (8 fish species), *Nymphaea alba* 47.1% (8 fish species), *Salvinia natans* 47.1% (8 fish species), *Stenochlaena palustris* 47.1% (8 fish species), *Phaspalum conjugatum* 47, 1% (8 fish species), *Bulbostylis juncoides* 41.2% (7 fish species), *Limnocharis flava* 35.6% (6 fish species), *Salvinia molesta* 35.3% (6 species fish), *Hydrocharis morsus* 29.4% (5 fish species), *Neptunia oleracea* 29.4% (5 fish), *Salvinia minima* 29.4% (5 fish), *Caladium* sp. 23.5% (4 fish), *Azolla pinnata* 17.6% (3 fish species), *Lemna perpusilla* 17.6% (3 fish species), *Bulbostylis barbata* 17.6% (3 fish species) and *Nymphaea lotus* 11.8 % (2 fish species). Meanwhile, the plant least used by fish for laying eggs and raising offspring was *Hydrilla verticillata* with only 1 species of fish (5.9%).

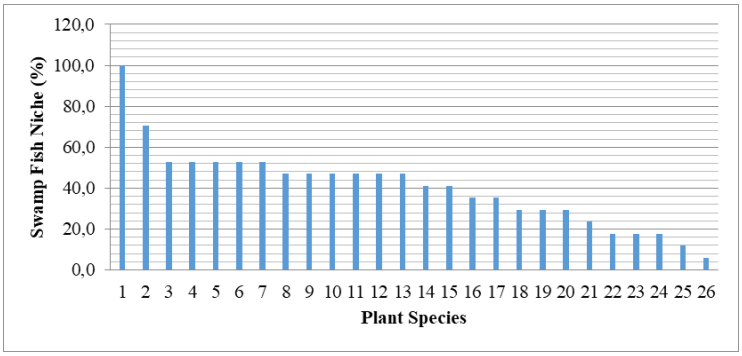

Figure 3. Percentage of fish species (of total 17 species) found in plant species in in three swamps in South Kalimantan Province

Notes:

1. *Eichornia crassipes*
2. *Pistia stratoites*
3. *Cyperus digitatus*
4. *Lemna minor*
5. *Nelumbo nucifera*
6. *Utricularia aurea*
7. *Crinum asiaticum*
8. *Diplazium esculentum*
9. *Hymenachne amplexicaulis*
10. *Ipomoea aquatica*
11. *Nymphaea alba*
12. *Salvinia natans*
13. *Stenochlaena palustris*
14. *Phaspalum conjugatum*
15. *Zoysia matrella*
16. *Limnocharis flava*
17. *Salvinia molesta*
18. *Hydrocharis morsus*
19. *Neptunia oleracea*
20. *Salvinia minima*
21. *Caladium sp.*
22. *Azolla pinnata*
23. *Lemna perpusilla*
24. *Megathyrsus maximus*
25. *Nymphaea lotus* L
26. *Hydrilla verticillata*

Based on the study results, the morphological characteristics of aquatic plants used by fish as niches for laying eggs and raising offspring/fry were related to the leaves and roots. *Eichornia crassipes* or water hyacinth was the most used plant species for niche by various types of swamp fish. *Eichornia crassipes* is a herbaceous plant with macrophyte or plant that float on water throughout its life. This plant has leaves arranged in a rosette, wide ovoid shape, which is very beneficial for fish to lay and attach eggs on a flat surface. In addition, the wide leaf will protect the eggs and offspring from the effects of direct sunlight. The water hyacinth root system is fibrous with many small, fertile and dense roots which are suitable for fish to laying eggs between these small roots. In addition, there was an abundance of organic and inorganic materials needed as food sources for young fish. The black color of the roots will protect the eggs and young fish from predators. Such morphological characteristics make this plant the most preferred by freshwater fish to lay eggs and raise their young. In this study, all the 17 freshwater species recorded in this study raise their juveniles around *Eichornia crassipes*. Our finding that *Eichornia crassipes* serves as a niche for fish reproduction is in line with other studies, such as Whetstone (2009), Gettys (2009), and Ismail et al. (2018).

Pistia stratoites has a single leaf type with dense leaves arrangement and dense rosettes, the leaves have spoon shape, the edges of the leaves are grooved with a smooth leaf surface and hairy stripes, the texture of the leaves is thick and soft with a length of 1.3-10 cm and a width of 1.5-6 cm. Such leaf morphology is very beneficial for fish to attach or lay eggs. In addition, the dense leaf blades or rosettes will protect the eggs and offspring from the effects of sunlight and water currents. However, the roots of this plant is at the bottom of the water, so fish cannot use it to attach or lay eggs.

In contrast, *Rasbora argyrotaenia* was found only in *Hydrilla verticillat*a which uses this plant to lay eggs and raise their young. *Hydrilla verticillata* is a herbaceous plant that lives in tightly spreading water. It has stems intercalated 0.7 cm-1.4 cm with single leaf lanceolate in shape and arranged at a circular layout of 3-6 leaves, leaf margins are serrated, leaf surface with a length of 0.6-2.5 cm and a width of 1.2-5.5 cm. The root system of this plant is fibers attached at the bottom of the water. Based on these morphological characteristics, the potential of plants as a niche for laying eggs and raising offspring is only in its leaves. In addition, with a dense habitus, it will be an obstacle for medium and large-sized fish for their reproductive purposes. So that only small fish can use this plant to lay eggs and raise juveniles, which in this study was *Rasbora argyrotaenia*. Another study also found *Hydrilla verticillata* as a fish niche was also reported by Ismail et al. (2018).

Based on the description above, the morphological characteristics of shape, size and number of leaves that float on the surface, and the shape and number of root fibers affected the presence of freshwater fish to lay eggs and maintain their juveniles. The larger the leaf size, the higher the number of leaves that cover the water surface, the rougher the leaf surface and edges, and the denser the root system in the water (not in the soil), the more fish is likely to lay eggs and raise young around plants with such characteristics. In addition, such morphological characteristics also will slow and calm the flow of water currents, making it suitable for laying eggs and raising fish. The dense roots in the water can hold and bind the

minerals and organic matters which might be beneficial for feeding the young fish. Aquatic plants with broad leaves have an important role as oxidizing agents, so they are very efficient in binding carbon dioxide in the water and releasing it into oxygen which is beneficial for young fish.

The concept of weeds in swamp habitat if viewed from the importance of maintaining fish diversity might not be relevant because swamp habitat is not an area used for productive plant cultivation. The existence of aquatic plants in the swamp habitat needs to be maintained so that the freshwater fish required by the people living in the area can always be maintained and used as a source of natural animal protein. Triyanto et al. (2019), Lende & Khileri (2021) found that fish use aquatic plants to lay eggs and reproduce on the leaf surface of aquatic plants. Thus, plant species that important as habitat niche of swamp fish need to be maintained and controlled. According to Fuller et al. (1998), integrating vegetation cover and other biodiversity such as fish can assist conservation planning.

In addition, we found that each fish that lived in the swamp never used one plant simultaneously with other fishes to raise young at the same time and place. Thus, one plant is only used by one type of fish in each spawning. The diversity of aquatic plant species in swamps affects swamp fish species' activity, growth, and territorial formation. This is in line with the concept of there is no two species use the same resources simultaneously Odum, 1993) which is also true for fish using aquatic plants as niches to lay eggs and raise their young. Thus it can be said that fish choose certain plants to lay their eggs and raise their young precisely without the presence of other fish to do the same. Research by Mouton et al. (2010) shows that differences in life histories or even gene flow of fish assemblages can result in different realization niches. Haller (2009), Costa et al. (2010) and Ismail et al. (2018) stated that the abundance of aquatic plants triggers the growth and condition of fish. The limitations and excess of aquatic plants in swamp areas can reduce the abundance of fish. According to (Mirmanto 2009), the negative correlation is the existence of competition between individual seeds at the beginning of growth, not between species.

In conclusion….

Berdasarkan uraian di atas dapat dinyatakan, bahwa makin banyak tumbuhan air yang terdapat di rawa akan membuat rawa menjadi niche ikan yang optimal bagi ikan untuk bertelur dan membesarkan anak. Hal tersebut akan berdampak positif terhadap keanekaragaman ikan di rawa. Oleh sebab keberadaan tumbuhan tersebut perlu dipertahankan dan ditingkatkan kesuburannya untuk menjamin perkembangan ikan air tawar, terutama yang hidup di rawa-rawa

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~~Exploration of a~~Aquatic plants as ~~a~~ niche for (laying eggs and raising juveniles ~~keep its fry) for~~ by freshwater fish in three swamp habitats in South Kalimantan, Indonesia

Abstract. Swamp is as an area that is almost always waterlogged throughout the year, making it very unique ecosystem. There is a wide variety of ecosystem services provided by swamp ecosystem, one of those is habitat of freshwater fish which is related to the presence of swamp vegetation. This study aimed to investigate swamp plants used as niches for freshwater fish to lay eggs and raise its offspring in three swamp areas in three regencies (i.e., Hulu Sungai Utara Regency, Tanah Laut Regency and Barito Kuala Regency) in South Kalimantan Province, Indonesia. Purposive random sampling was conducted in each swamp by observing and documenting the types of plants where fish eggs and offspring found. We recorded 26 species of aquatic plants used by 17 species of swamp fish to lay eggs and raise offspring/fry. *Eichornia crassipes* was the most widely used aquatic plant species with 100% of all freshwater fish species found (17 fish species), followed by *Pistia stratoites* by 70.6% (12 fish species) and *Cyperus digitatus*, *Lemna minor*, *Nelumbo nucifera*, *Utricularia aurea* and *Crinum asiaticum* with each used by 52.9% (9 fish species). ~~Around 208.893 ha of the total area of South Kalimantan is the swamp. The swamp vegetation lives in symbiosis with the animals around it. Many studies have examined the two separately, but specific interactions between aquatic animals and marsh plant species are rarely observed here. Aquatic animals such as fish are very dependent on the presence of plants that live in swamps as niches or microhabitats, especially for shelter and breeding. This study aimed to explore swamp plants used as freshwater fish niches to lay eggs and raise young. The research method used is descriptive quantitative research. The study population was all plants found in three swamp habitats in South Kalimantan, Indonesia, namely the swamps of the North Hulu Sungai Regency, the swamps of the Tanah Laut Regency, and the swamps of the Barito Kuala Regency. The research sample was determined by purposive random sampling in each swamp to the types of plants found in fish eggs and chicks. The research data were analyzed descriptively. The study results found 26 species of plants used by 17 species of swamp fish as niches in laying eggs and raising young. Therefore, the~~These plant species ~~types of plants~~ favored by fish need to be maintained and controlled. ~~Their fertility increased to ensure~~ to support the population of the fish. ~~the breeding of freshwater fish and need to be disseminated to the public through education or counseling about the potential, threats, and conservation of swamps, especially the presence of aquatic plants on the presence of freshwater fish in swamp habitats.~~

Keywords: Swamp plants, a place to stand and raise young fish

Running title: Exploration of aquatic plants as a niche for freshwater fish

INTRODUCTION

Based on the 1971 Ramsar Convention, ~~The definition of a~~ swamp ~~based on the 1971 Ramsar Convention~~ is defined as an area that is almost always waterlogged throughout the year, naturally formed on relatively flat or sunken land with mineral deposits or peat and overgrown with vegetation (Matthews, 2013). Swamps are waterlogged, acidic, anoxic, and oligotrophic ecosystems (Too et al., 2021). Swamps ecosystems ~~are distributed in ecosystems~~ as floodplain areas provide a wide variety of ecosystem services (Phiri et al., 2021), including and maintaining hydrological and carbon cycles between land and atmosphere (Ohkubo et al., 2021), medium of seeds distribution (Lei & Middleton, 2021), and the habitat of aquatic plants and animals (Padil et al., 2021). For example, a study in the Tripa peat swamp forest, Indonesia recorded 41 species of herbaceous plants ~~, seed banks (Lei & Middleton, 2021), the transition of water between land and atmosphere (Ohkubo et al., 2021), and~~ (Djufri et al., 2016).

Despite their importance, ~~aquatic plants used as media for cultivation. organisms and kinetic studies (Padil et al., 2021). I~~in the last decades, swamp ecosystems, particularly in the tropics, have been pressured by various human activities such as ~~experienced many phenomena,~~logging, deforestation and degradation, and land conversion, making it prone to ~~such as swamp forest~~ large fires especially ~~, which occur more frequently in~~during the dry season (Kubik et al., 2020). This phenomenon~~,~~ caused~~d by~~ changes in the environment and climate (Lei & Middleton, 2021), thus affecting the carbon cycle of the swamp ecosystem~~.~~ (Liu et al., 2020)~~,~~ and threatening its biodiversity including the vegetation ~~swamp animal populations are decreasing due to reduced niches~~ (Paul et al., 2020). The continuing habitat loss could result in

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biodiversity loss before known full species diversity (Barletta et al., 2010). Therefore, prudent management of aquatic habitats including swamp ecosystem is needed to conserve aquatic biodiversity (Ndehedehe et al., 2020).

Peat swamp ecosystem is one of the unique habitats that has high species endemism (Joni et al., 2015). Different vegetation in this ecosystem indicates niche formation due to unique biotic and abiotic factors which is mainly caused by the waterlogged condition and highly acidic water and soils. However, small-scale spatial variations show the stochastic nature of the vegetation (DiMichele et al., 2017). Niche area and trophic diversity can indicate resource use according to trophic availability, regardless of size or gender (Correia, 2002). For instance, ridge-hollow swamps can generate ecological niche in strongly acidic aqueous media with specific aquatic plants and animals that may live in the area (Rybina et al., 2014). According to Kłosowski & Jabłońska (2009), habitat conditions in water bodies are distinguished based on the dominance of aquatic plant species associated with particular habitats. For example, bitter-fruited and sweet-fruited vegetation might require different ecological niches (Vihotogbé et al., 2019).

Whetstone (2009) states that vegetation occurring in swamp ecosystem can be classified into three groups, namely surface plants, floating plants, and submerged plants. Surface plants have roots at the bottom of the water with leaves extending upward to the water surface, for example, *Sagittaria sinensis* and *Phragmites communis*. Meanwhile, Goel (2006) stated that floating plants are plants whose roots hang in the water or do not touch the bottom of the water, for example, *Nymphaea* sp. and *Nelumbo* sp. Submerged plants are plants that live entirely in water, such as *Hydrilla verticillate*, *Najas minor*, *Chara vulgaris* and *Ceratophyllum demersum*.

Aquatic plants in swamp ecosystem play an essential role for fish life (Kurniawan & Paramita, 2019). Aquatic animals such as fish are very dependent on the presence of plants that live in swamps as a niche or micro-habitat, especially for shelter and breeding (Raharjo, 2018). The abundance of aquatic plants is positively correlated with fish populations (Odum, 1993). Habitats with moderate amounts of aquatic plants provide an optimal environment for many fish to increase fish diversity, feeding, growth, and reproduction. In contrast, limited or excessive vegetation cover can reduce the growth rate of fish by 75% to 85% (Ismail et al., 2018). Fish uses aquatic plants to lay eggs on the leaf surface of aquatic plants or among smooth-leaved plants on mangrove vegetation (Triyanto et al., 2019). For example, the parent fish *Chlaria batracus* and fish *Melanotaenia* sp. usually form pairs, lay eggs, and protect eggs and seeds from harm under aquatic plants (Lende & Khileri, 2021).

Each type of plant has specific morphological characteristics to adapt to its habitat (Steenis, 2013). In swamp ecosystem, the morphological characteristics of swamp vegetation are thought to be used by freshwater fish species as living and growing habitats. Based on the research results of Ismail et al. (2018), no research results have been found that report certain types of plants selected by certain types of fish as a niche for laying eggs and raising its offspring. In addition, the types of plants favored by fish need to be maintained, and their fertility needs to be increased.

This study aimed to investigate swamp plants used as niches for freshwater fish to lay eggs and raise its offspring in three swamp areas in South Kalimantan Province, Indonesia. The swamps in South Kalimantan, or locally called *lebak*, provide excellent context of study since the province has swamp area of 208.893 ha with vegetation dominated by shrubs and shrubs. We expect the results of this study can be disseminated to the people living around the swamps through raising awareness about the potential uses, threats, and conservation of swamps, especially the influence of aquatic plants on the presence of freshwater fish in swamp habitats, and even deliberately restore the degraded swamp to increase fish population.~~The largest swamp in South Kalimantan is the lebak swamp, either seasonally or permanently. The lebak swampland area in South Kalimantan is about 208.893 ha, with vegetation dominated by shrubs and shrubs. Swamp forest vegetation can adapt to anaerobic areas and are flooded seasonally or permanently. Whetstone (2009) states that swamp plant vegetation based on its presence in water is grouped into three groups, namely surface plants, floating plants, and submerged plants. Surface plants have roots at the bottom of the water with leaves extending upward to the water's surface, for example, *Sagittaria Sinensis* and *Phragmites communis*.~~

~~Meanwhile, Goel (2006) stated that floating plants are plants whose roots hang in the water or do not touch the bottom of the water, for example, *Nymphaea* sp. and *Nelumbo* sp. Submerged plants are plants that live entirely in water, such as *Hydrilla verticillate*, *Najas minor*, *Chara Vulgaris*, and *Ceratophyllum demersum*. The research results conducted by Djufri et al. (2016) found 41 species of herbaceous plants in the Tripa peat swamp forest, Indonesia.~~

~~The peat swamp ecosystem is one of the essential areas and is a habitat that has high species endemism (Joni et al., 2015). Different vegetation in this ecosystem zoning indicates niche formation. However, small-scale spatial variations indicate the stochastic nature of the vegetation (DiMichele et al., 2017). Bitter-fruited and sweet-fruited vegetation can also form different ecological niches (Vihotogbé et al., 2019). Niche area and trophic diversity can indicate resource use according to trophic availability, regardless of size or gender (Correia, 2002). Ridge-hollow swamps can generate ecological niche/niche skeletons in strongly acidic aqueous media (Rybina et al., 2014), predicting what aquatic plants and aquatic animals may live in the area. Ndehedehe et al. (2020) stated that the management of aquatic habitats could support the maintenance of aquatic biodiversity. According to Barletta et al. (2010), continued habitat loss could result in biodiversity loss before known full species diversity. According to Kłosowski & Jabłońska (2009), in addition to the wide variability, habitat conditions in water bodies are distinguished based on the dominance of aquatic plant species associated with particular habitats.~~

~~Aquatic plants in swamp vegetation habitats play an essential role for fish life (Kurniawan & Paramita, 2019). Aquatic animals such as fish are very dependent on the presence of plants that live in swamps as a niche or micro-habitat,~~

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~~especially for shelter and breeding (Raharjo, 2018). Niche signifies the place of animals in their biotic and abiotic environment related to food and their enemies. In other words, niche describes the status of animals in their community to show what they do. The abundance of aquatic plants is positively correlated with fish populations (Odum, 1993). Habitats with moderate amounts of aquatic plants provide an optimal environment for many fish to increase fish diversity, feeding, growth, and reproduction.~~

~~On the other hand, limited and excessive vegetation can reduce the growth rate of fish by 75% to 85% of the coverage of the plant community (Ismail et al., 2018). Fish uses aquatic plants to lay eggs on the leaf surface of aquatic plants or among smooth-leaved plants on mangrove vegetation (Triyanto et al., 2019). For example, the parent fish *Chlaria batracus* and fish *Melanotaenia* sp. usually form pairs, lay eggs, and protect eggs and seeds from harm under aquatic plants (Lende & Khileri, 2021).~~

~~Each type of plant has specific morphological characteristics to adapt to its habitat (Steenis, 2013). These morphological characteristics are thought to be used by freshwater fish species as living and growing habitats. Based on the research results of Ismail et al. (2018) and other scientific journals, no research results have been found that report certain types of plants selected by certain types of fish as a niche for laying eggs and raising their young. In addition, the types of plants favored by fish need to be maintained, and their fertility needs to be increased. This aims to ensure the breeding of freshwater fish. This contribution needs to be disseminated to the people living around the swamps through education or counseling about the potential, threats, and conservation of swamps, especially the presence of aquatic plants on the presence of freshwater fish in swamp habitats, and even deliberately planted so that there are more fish. Therefore, this study aims to explore the types of swamp plants that are "chosen" by freshwater fish as niches for laying eggs and maintaining their seeds.~~

MATERIALS AND METHODS

Study area and period

This research was carried out in three swamp habitats in South Kalimantan, Indonesia, ~~where freshwater fish are found~~ namely Rawa Hulu Sungai ~~Selatan~~ Utara Regency, Rawa Tanah Laut Regency, and Barito Kuala Regency in April 2021. The area of swamps being observed in the Hulu Sungai Utara Regency was 92.5 Ha, the Tanah Laut Regency Swamp was 56.7 Ha, and the Barito Kuala Regency Swamp was 47.2 Ha (Figure 1).

PLEASE ADD HERE THE GENERAL DESCRIPTION OF THE THREE STUDIED AREA, INCLUDING THE VILLAGE/SUB-DISTRICT NAME (I NOTE IN THE MAP THAT YOU PROVIDED VILLAGE/SUB-DISDTRICT NAME), GEOGRAPHICAL COORDINATES, ELEVATION, TEMPERATURE, HUMIDITY, ANNUAL RAINFALL AND THE VEGETATION CONDITION OF EACH STUDY SITE.

Data collection procedure

~~This e type of~~ research used observational techniques ~~with~~is descriptive analysis~~research with observational techniques~~. ~~The area of observation swamps in the North Hulu Sungai Regency is 92.5 Ha, the Tanah Laut Regency Swamp is 56.7 Ha, and the Barito Kuala Regency Swamp is 47.2 Ha (Figure 1).~~ The research sample was determined by purposive random sampling in each swamp by observing and documenting the types of plants where ~~found in~~ fish eggs and ~~chicks~~ offspring found~~as data for the niche of swamp fish to lay eggs and raise offspring~~. Determination of plant species using a plant observation guide. Determination of the type of plant ~~"chosen"~~preferred by fish as a niche in laying eggs and raising offspring/fry ~~young~~ is based on the finding eggs, ~~fish fry~~offspring, and mother fish around the plants. Determination of the type of parent fish using a fish observation guide. The research data were analyzed descriptively.

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Figure 1. Map of ~~three research l~~Locations in three regencies in South Kalimantan Province, Indonesia: Hulu Sungai Selatan, Tanah Laut and Barito Kuala. ~~of research~~

RESULTS AND DISCUSSION

~~The results of the research show that swamp plants have potential as niches. This is based on discovering eggs, juveniles, and broodstock of swamp fish around swamp plants in three swamp areas of Kalimantan, Indonesia.~~ In our study, ~~T~~there were~~are~~ 26 species~~types~~ of aquatic plants used by 17 species of swamp fish to lay eggs and raise offspring/fry~~,~~ as shown in Table 1. The number of ~~is study also indicates that~~ aquatic plants ~~were~~ used as fish niches in this study is more than ~~the research~~in the study conducted by Ismail et al. (2018) which only found~~. Ismail et al. (2018)~~ found nine ~~eight~~ plant species, i.e.,~~:~~ *Lemna m~~M~~inor*, *Polygonum barbatum*, *Eichhornia crassipes*, *Pistia stratiotes*, *Neptunia oleracea*, *Hydrilla verticillata*, *Salvinia molesta*, *Phragmites australis*, and *Azolla pinnata*. ~~However, this study's results did not specifically explain what freshwater fish species most favored plants.~~

Tabel 1. ~~Swamp P~~Plant~~s~~ species used by fish to ~~l~~lay eggs and raise offspring/fry in three swamps in South Kalimantan Province ~~Potential as Swamp Fish Niche~~

No.	Plant Species	Fish Species															
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	*Azolla pinnata*		F													F	F	
2	*Caladium* sp.		F							F						F		F
3	*Cyperus digitatus*		E	E	F	E				F			F			F	F	F
4	*Diplazium esculentum*	F	E	E				F						F		F		F
5	*Phaspalum conjugatum*	F		E	F	E		F		F				F			F	
6	*Eichornia crassipes*	F	E	E	F	F	E	F	F	F	E	F	F	F	F	F	F	E
7	*Hydrilla verticillata*														F			
8	*Hydrocharis Morsus*	F						F						F		F		F
9	*Hymenachne amplexicaulis*	F	E	E		E		F						F		F		E
10	*Ipomoea aquatica*		E	F	F				F	F		F			E		F	
11	*Lemna Minor*		E	E	F	E					E	F			F	F		E
12	*Lemna perpusilla*														F	F		E
13	*Limnocharis flava*	F						F						F		F	F	F
14	*Megathyrsus maximus*				F	F				F								
15	*Nelumbo nucifera*		F	E	F	E	E					F				F	F	F
16	*Neptunia oleracea*			F			F		F							F		E
17	*Nymphaea alba*		F	E	F						F		E		F	F		E
18	*Nymphaea lotus* L.															F		E
19	*Pistia stratoites*	F	E	F	F	E		F	F			F		F		F	F	F
20	*Salvinia minima*		E	F					F							F		F
21	*Salvinia molesta*									F		F			E	F	F	E
22	*Salvinia natans*		E	E		E			F	F						F	F	E
23	*Stenochlaena palustris*	F						F		F			F	F		F	F	F
24	*Utricularia aurea*	F	E	E	F	E		F						F		F		F
25	*Zoysia matrella*	F		F				F	F					F		F		E
26	*Crinum asiaticum*		E		F				F			F	F	F	E		F	E

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Notes: E = eggs, F = fry

A	*Channa striata*	G	*Channa micropeltes*	M	*Channa lucius*
B	*Anabas testudineus*	H	*Cyprinus carpio*	N	*Rasbora argyrotaenia*
C	*Trichogaster trichopterus*	I	*Pampus argenteus*	O	*Mystus ssScopoli*
D	*Rasbora dusonensis*	J	*Clarias batrachus*	P	*Osteochilus hasselti*
E	*Trichogaster pectoralis*	K	*Criptopterus spp*	Q	*Oxyeleotris marmorata*
F	*Helestoma temminkii*	L	*Hemibagrus nemurus*		

Based on research conducted in April 2021, it can be seen that the presence of fish in swamp plants hads two forms, namely still in the form of eggs (, which are indicated by the presence of foam around the plants) and in the form of tillersoffspring/fry (Table 1 and Figure 2). This finding suggestsshows that the reproduction period of freshwater fish is different or happening not at the same time. This is in accordance with Setyaningrum and Wibowo (2017) who reported the reproductive ability of 5 fish species (i.e., *Cyprinus carpio*, *Barbonymus gonionatus*, *Osteochillus vittatus* *Oreochromis niloticus*, and *Clarias gariepinus*) which showeds difference in reproduction periods. Devkota & Kathayat (2020) explained that climate change greatly affects the reproduction, development, structure, and abundance of freshwater fish populations. In addition, the reproductive potential of fish depends on the development of the gonads until the fish spawn and produce seeds. Based on information from the people living in the three swamp areas studied, the breeding season for fish in the area indicated by the presence of fish eggs and offspring/frychicks is from February to August.

Figure 2. The presence of haruan fish eggs and offspringchicks in aquatic plants

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Niche signifies an animal's placeanimal habitat in its biotic and abiotic environment in relation to food and its enemies or indicates what it does (Odum, 1993). Based on this concept and Figure 3, it can be seen that the dominant or most widely used aquatic plant by fish that live in swamps as a niche for laying eggs and rearing offspring wasyoung is *Eichornia crassipes* with 100% of all freshwater fish species found (17 fish species), then followed by by *Pistia stratoites* by 70.6% (12 fish species), *Cyperus digitatus* 52.9% (9 fish species), *Lemna mMinor* 52.9% (9 fish species), *Nelumbo nucifera* 52.9% (9 fish species), *Utricularia aurea* 52.9% (9 fish species), *Crinum asiaticum* 52.9% (9 fish species), *Diplazium esculentum* 47.1% (7 fish species), *Hymenachne amplexicaulis* 47.1% (8 fish species), *Ipomoea aquatica* 47.1% (8 fish species), *Nymphaea alba* 47.1% (8 fish species), *Salvinia natans* 47.1% (8 fish species), *Stenochlaena palustris* 47.1% (8 fish species), *Phaspalum conjugatum* 47, 1% (8 fish species), *Bulbostylis juncoides* 41.2% (7 fish species), *Limnocharis flava* 35.6% (6 fish species), *Salvinia molesta* 35.3% (6 species fish), *Hydrocharis mMorsus* 29.4% (5 fish species), *Neptunia oleracea* 29.4% (5 fish), *Salvinia minima* 29.4% (5 fish), *Caladium* sp. 23.5% (4 fish), *Azolla pinnata* 17.6% (3 fish species), *Lemna perpusilla* 17.6% (3 fish species), *Bulbostylis barbata* 17.6% (3 fish species) and, *Nymphaea lotus* 11.8 % (2 fish species). Meanwhile, the plant least used by fish for laying eggs and raising offspringchildren wasis *Hydrilla verticillata*, with only 1 species of fishwhich is (5.9%) (1 species of fish). This shows that swamp plant species determine the types of freshwater fish to lay eggs and raise young.

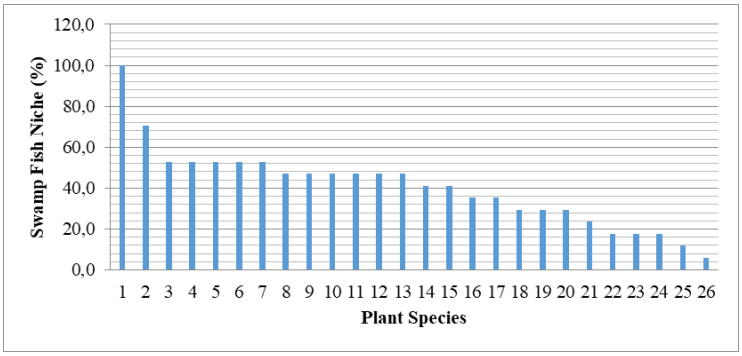

Figure 3. Percentage of fish species (of total 17 species) found in plant species in in three swamps in South Kalimantan Province ~~Swamp Plants Potential as Swamp Fish Niche (%)~~

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Notes:

1. *Eichornia crassipes*
2. *Pistia stratoites*
3. *Cyperus digitatus*
4. *Lemna mMinor*
5. *Nelumbo nucifera*
6. *Utricularia aurea*
7. *Crinum asiaticum*
8. *Diplazium esculentum*
9. *Hymenachne amplexicaulis*
10. *Ipomoea aquatica*
11. *Nymphaea alba*
12. *Salvinia natans*
13. *Stenochlaena palustris*
14. *Phaspalum conjugatum*
15. *Zoysia matrella*
16. *Limnocharis flava*
17. *Salvinia molesta*
18. *Hydrocharis mMorsus*
19. *Neptunia oleracea*
20. *Salvinia minima*
21. *Caladium sp.*
22. *Azolla pinnata*
23. *Lemna perpusilla*
24. *Megathyrsus maximus*
25. *Nymphaea lotus* L
26. *Hydrilla verticillata*

Based on the study results, the morphological characteristics of aquatic plants used by fish as niches for laying eggs and raising offspring/fry ~~young are the morphological characteristics of the~~ were related to the leaves and roots ~~of these plants~~. ~~The plant species~~ *Eichornia crassipes* or water hyacinth was~~is~~ ~~an aquatic plant with~~the most used plant species for niche ~~the widest niche for~~ by various types of swamp fish. ~~As an illustration, the following describes the characteristics of the *Eichornia crassipes* plant as the most preferred plant for fish to lay eggs and raise young fish.~~ *Eichornia crassipes* is a herbaceous plant with macrophyte~~s~~ or plant~~s~~ that float on water throughout its~~their~~ life~~ves~~. This plant has leaves arranged in a rosette, wide ovoid shape, which is very beneficial for fish to lay and attach eggs ~~to fish that lay their eggs~~ on a flat surface. In addition, the wide leaf ~~blades~~ will protect the eggs and offspring~~chicks~~ from the effects of direct sunlight. The water hyacinth root system is fibrous with many small, fertile~~,~~ and dense roots ~~that will be~~which are suitable for fish to laying eggs between these small roots. In addition, ~~small, fertile, and dense roots are found~~ there was~~in~~ an abundance of organic and inorganic materials needed as food sources for young fish. The black color of the roots will protect the eggs and young fish from predators. Such morphological characteristics make this plant the most preferred by freshwater fish to lay eggs and raise their young. In this study, all the ~~fish found were~~ 17 freshwater species recorded in this study ~~that live in the spawning swamp and~~ raise their juveniles around~~young in~~ *Eichornia crassipes*. Our finding ~~The results of other studies that also found~~that *Eichornia crassipes* serves as a ~~fish~~ niche for fish reproduction is in line with other studies, such as~~were carried out by~~ Whetstone (2009), Gettys (2009), and Ismail et al. (2018).

Pistia stratoites has~~ve~~ a single leaf type with dense leaves arrangement and ~~a leaf arrangement of dense and~~ dense ~~root~~ rosettes~~, the shape of~~ the leaves have~~in~~ spoon~~the~~ shape ~~of a spoon~~, the edges of the leaves are grooved~~,~~ with a smooth leaf surface and~~with~~ hairy stripes, the texture of the leaves is thick and soft with a length of 1.3-10 cm and a width of 1.5-6 cm. Such leaf morphology is very beneficial for fish to attach or lay eggs. In addition, the dense~~gathered~~ leaf blades or rosettes will protect the eggs and offspring~~chicks~~ from the effects of sunlight and water currents ~~or water waves~~. However, ~~T~~the roots of this plant ~~enter~~is at the bottom of the water, so fish cannot use it to attach or lay eggs.

In contrast, ~~Meanwhile, only~~ *Rasbora argyrotaenia* was found only in *Hydrilla verticillat*ae~~,~~ which uses this plant to lay eggs and raise their young. *Hydrilla verticillata* is a herbaceous plant~~habit~~ that lives in tightly spreading water. It has stems ~~having~~ intercalated 0.7 cm-1.4 cm ~~branched~~ with single leaf~~ves~~ lanceolate in shape and arranged~~, with~~ at a circular layout of 3-6 leaves ~~that are lanceolate in shape~~, leaf margins are serrated, leaf surface with a length of 0.6-2.5 cm and a width of 1.2-5.5 cm. The root system of this plant is ~~the~~ fibers ~~stuck to~~attached at the bottom of the water. Based on these morphological characteristics, the potential of plants as a niche for laying eggs and raising offspring~~young~~ is only in its leaves. In addition, with a dense habitus, it will be an obstacle for medium and large-sized fish for their reproductive purposes. So that only small fish can use this~~ese~~ plant~~s~~ to lay eggs and raise ~~children~~juveniles, which in this study was~~is~~

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Rasbora argyrotaenia. ~~The results of a~~Another study ~~which~~ also found *Hydrilla verticillata~~e~~* as a fish niche was also~~, were~~ reported by Ismail et al. (2018).

Based on the description above, the morphological characteristics of shape, size and~~,~~ number of~~, and~~ leaves that float on the surface, and the shape~~,~~ and number of root fibers ~~that float in water are used mainly by~~affected the presence of freshwater fish to lay eggs and maintain their juvenile~~sseeds~~. The larger the leaf size, ~~and~~ the higher the number of leaves that cover the water surface, the rougher the leaf surface and edges, and~~,~~ the denser the root system ~~of plant fibers~~ in the water (not in the soil), the more fish is likely to ~~choose these plants to~~ lay eggs and raise young around plants with such characteristics. In addition, such morphological characteristics also ~~the wide and abundant leaf morphology~~ will slow and calm the flow of water ~~by~~ currents, ~~the surrounding waters become calm,~~ making it suitable~~effective~~ for laying eggs and raising fish. The ~~Rhizomes and~~ dense roots in the water can hold and bind the minerals and organic matters which might be beneficial for~~, and~~ feeding the young fish ~~need to grow organic matter~~. Aquatic plants with broad leaves ~~in or on the surface of the water~~ have an important role as oxidizing agents ~~in the water~~, so they are very efficient in binding carbon dioxide in the water and releasing it into oxygen which is beneficial for young fish.

The concept of weeds in swamp habitat if~~, when~~ viewed from ~~the point of view of~~ the importance of maintaining fish diversity~~, should not be used~~ might not be relevant because swamp habitat is not an area used for productive plant cultivation. The existence of aquatic plants in the swamp habitat needs to be maintained so that the freshwater fish required by the people living in the area can always be maintained and used as a source of natural animal protein. ~~As reported by~~ Triyanto et al. (2019)~~,~~ Lende & Khileri (2021)~~,~~ found that fish use aquatic plants to lay eggs and reproduce on the leaf surface of aquatic plants~~.~~ Thus, ~~among smooth-leaved plants and under aquatic plants.~~

~~Therefore, t~~plant species that important as habitat niche of swamp ~~he types of plants found by these~~ fish need to be maintained and controlled~~, and their fertility increased to ensure the development of freshwater fish, especially those that live in swamps~~. ~~This needs to be disseminated to the people living around the swamps through education or counseling about the potential threats and conservation of swampland, especially the presence of aquatic plants on the presence of freshwater fish in the swamp habitat. People are used to throwing this plant around the swamp because it is considered a weed or disturbing their boats.~~ According to Fuller et al. (1998), integrating vegetation cover and other biodiversity such as fish can assist conservation planning.

In addition, we found that each~~every~~ fish that lived in the swamp never used one plant simultaneously with other fishes~~together~~ to raise young at the same time and place. Thus, one plant is only used by one type of fish in each spawning. The diversity of aquatic plant species in swamps affects swamp fish species' activity, growth, and territorial formation. This is in line with the concept of there is no two species use the same resources simultaneously Odum, 1993) which is also true for fish using aquatic plants as niches to lay eggs and raise their young~~As Gause (Odum, 1993) explains that no two species use the same resources simultaneously, this is also true for fish using aquatic plants as niches to lay eggs and raise their young~~. Thus it can be said that fish choose certain plants to lay their eggs and raise their young precisely without the presence of other fish to do the same. Research by Mouton et al. (2010) shows that differences in life histories or even gene flow of fish assemblages can result in different realization niches. Haller (2009), Costa et al. (2010) and~~,~~ Ismail et al. (2018) stated that the abundance of aquatic plants triggers the growth and condition of fish. The limitations and excess of aquatic plants in swamp areas can reduce the abundance of fish. According to (Mirmanto 2009), the negative correlation is the existence of competition between individual seeds at the beginning of growth, not between species.

In conclusion….

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Aquatic plants as niche for lay eggs and raising juveniles by freshwater fish in three swamp habitats in South Kalimantan, Indonesia

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Abstract. *Dharmono, Mahrudin, Irianti R, Fajeriadi H. 2022. Aquatic plants as niche for lay eggs and raising juveniles by freshwater fish in three swamp habitats in South Kalimantan, Indonesia. Biodiversitas 23: xxxx.* Swamp is as an area that is almost always waterlogged throughout the year, making it very unique ecosystem. There is a wide variety of ecosystem services provided by swamp ecosystem, one of those is habitat of freshwater fish which is related to the presence of swamp vegetation. This study aimed to investigate swamp plants used as niches for freshwater fish to lay eggs and raise its offspring in three swamp areas in three regencies (i.e., Hulu Sungai Utara Regency, Tanah Laut Regency and Barito Kuala Regency) in South Kalimantan Province, Indonesia. Purposive random sampling was conducted in each swamp by observing and documenting the types of plants where fish eggs and offspring found. We recorded 26 species of aquatic plants used by 17 species of swamp fish to lay eggs and raise offspring/fry. *Eichornia crassipes* was the most widely used aquatic plant species with 100% of all freshwater fish species found (17 fish species), followed by *Pistia stratoites* by 70.6% (12 fish species) and *Cyperus digitatus*, *Lemna minor*, *Nelumbo nucifera*, *Utricularia aurea* and *Crinum asiaticum* with each used by 52.9% (9 fish species). These plant species favored by fish need to be maintained and controlled to support the population of the fish.

Keywords: Swamp plants, a place to stand and raise young fish

INTRODUCTION

Based on the 1971 Ramsar Convention, swamp is defined as an area that is almost always waterlogged throughout the year, naturally formed on relatively flat or sunken land with mineral deposits or peat and overgrown with vegetation (Matthews, 2013). Swamps are waterlogged, acidic, anoxic, and oligotrophic ecosystems (Too et al., 2021). Swamps ecosystems as floodplain areas provide a wide variety of ecosystem services (Phiri et al., 2021), including maintaining hydrological and carbon cycles between land and atmosphere (Ohkubo et al., 2021), medium of seeds distribution (Lei & Middleton, 2021), and the habitat of aquatic plants and animals (Padil et al., 2021). For example, a study in the Tripa peat swamp forest, Indonesia recorded 41 species of herbaceous plants (Djufri et al., 2016).

Despite their importance, in the last decades, swamp ecosystems, particularly in the tropics, have been pressured by various human activities such as logging, deforestation and degradation, and land conversion, making it prone to large fires especially during the dry season (Kubik et al., 2020). This phenomenon causes changes in the environment and climate (Lei & Middleton, 2021), thus affecting the carbon cycle of the swamp ecosystem (Liu et al., 2020) and threatening its biodiversity including the vegetation (Paul et al., 2020). The continuing habitat loss in swamp ecosystem could result in biodiversity loss before it is known their species diversity (Barletta et al., 2010). Therefore, prudent management of aquatic habitats including swamp ecosystem is needed to conserve aquatic biodiversity (Ndehedehe et al., 2020)

Peat swamp ecosystem is one of the unique habitats that has high species endemism (Joni et al., 2015). Different vegetation in this ecosystem indicates niche formation due to unique biotic and abiotic factors which is mainly caused by the waterlogged condition and highly acidic water and soils. However, small-scale spatial variations show the stochastic nature of the vegetation (DiMichele et al., 2017). Niche area and trophic diversity can indicate resource use according to trophic availability, regardless of size or sex (Correia, 2002). For instance, ridge-hollow swamps can generate ecological niche in strongly acidic aqueous media with specific aquatic plants and animals that may live in the area (Rybina et al., 2014). According to Kłosowski & Jabłońska (2009), habitat conditions in water bodies are distinguished based on the dominance of aquatic plant species associated with particular habitats. For example, bitter-fruited and sweet-fruited vegetation might require different ecological niches (Vihotogbé et al., 2019).

Whetstone (2009) states that vegetation occurring in swamp ecosystem can be classified into three groups, namely surface plants, floating plants, and submerged plants. Surface plants have roots at the bottom of the water with leaves extending upward to the water surface, for example, *Sagittaria sinensis* and *Phragmites communis*. Meanwhile, Goel (2006) stated that floating plants are plants whose roots hang in the water or do not touch the

bottom of the water, for example *Nymphaea* sp. and *Nelumbo* sp. Submerged plants are plants that live entirely in water, such as *Hydrilla verticillate*, *Najas minor*, *Chara vulgaris* and *Ceratophyllum demersum*.

Aquatic plants in swamp ecosystem play an essential role for fish life (Kurniawan & Paramita, 2019). Aquatic animals such as fish are very dependent on the presence of plants that live in swamps as a niche or micro-habitat, especially for shelter and breeding (Raharjo, 2018). The abundance of aquatic plants is positively correlated with fish populations (Odum, 1993). Habitats with moderate amounts of aquatic plants provide an optimal environment for many fish to increase fish diversity, feeding, growth, and reproduction. In contrast, limited or excessive vegetation cover can reduce the growth rate of fish by 75% to 85% (Ismail et al., 2018). Fish uses aquatic plants to lay eggs on the leaf surface of aquatic plants or among smooth-leaved plants on mangrove vegetation (Triyanto et al., 2019). For example, the parent fish *Chlaria batracus* and fish *Melanotaenia* sp. usually form pairs, lay eggs, and protect eggs and seeds from harm under aquatic plants (Lende & Khileri, 2021).

Each type of plant has specific morphological characteristics to adapt with its habitat (Steenis, 2013). In swamp ecosystem, the morphological characteristics of swamp vegetation are thought to be used by freshwater fish species as living and growing habitats. Based on the research results of Ismail et al. (2018), no research results have been found that report certain types of plants selected by certain types of fish as a niche for laying eggs and raising its offspring. In addition, the types of plants favored by fish need to be maintained, and their fertility needs to be increased.

This study aimed to investigate swamp plants used as niches for freshwater fish to lay eggs and raise its offspring in three swamp areas in South Kalimantan Province, Indonesia. The swamps in South Kalimantan, or locally called *lebak*, provide excellent context of study since the province has swamp area of 208.893 ha with vegetation dominated by shrubs and shrubs. We expect the results of this study can be disseminated to the people living around the swamps through raising awareness about the potential uses, threats, and conservation of swamps, especially the influence of aquatic plants on the presence of freshwater fish in swamp habitats, and even deliberately restore the degraded swamp to increase fish population.

MATERIALS AND METHODS

Study area and period

This research was carried out in three swamp habitats in South Kalimantan, Indonesia, namely Rawa Hulu Sungai Utara Regency, Rawa Tanah Laut Regency, and Barito Kuala Regency in April 2021 (Figure 1). The research site in Hulu Sungai Utara Regency is located at the coordinates of 2°36'17.10" South latitude and 115°5'54.59" East longitude at an altitude of 15-17 m above sea level (asl) with temperatures ranging from 21-35°C and average rainfall of 384.5 mm/year. The area of the swamp studied was 92.5 ha in the form of lowland swamp influenced by tidal river water and rainwater with a diversity of flora dominated by aquatic herbaceous plants of Hidrocharitaceae, Cyperaceae, and Poaceae. The people who live around the swamp are farmers, swamp buffalo breeders and fishermen.

The research site in Tanah Laut Regency is located at the coordinates of 114.583° – 114.711° East longitude and 3.56309° – 3.72364° South latitude at an altitude of ± 0.5-1 m asl with temperatures ranging from 21-36°C and average rainfall of 203.8 mm/year. The area of the swamp studied was 56.7 ha in the form of mangrove swamp which was influenced by tides of sea water and river water with a salinity of 0-7 ppm. The diversity of flora was dominated by aquatic herbaceous plants in the form of Mangroves, Hidrocharitaceae, Cyperaceae, and Poaceae. The people who live around the swamp are farmers and fishermen.

The research site in Barito Kuala Regency is located at the coordinates of 3°15'25" – 3°20'72" South latitude and 114°38'28" – 114°68'17" East longitude at an altitude of ± 0.5-1 m asl with a temperature ranged from 23-35°C and the average rainfall was 248.23 mm/year. The area of the swamp studied is 47.2 ha in the form of a monton swamp which is inundated throughout the year. Diversity of flora dominated by aquatic herbaceous plants in the form of Hidrocharitaceae, Cyperaceae, Poaceae, and Myrtaceae. The people living around the swamp are farming communities, seekers of galam wood and fishermen.

Data collection procedure

This research used observational techniques with descriptive analysis. The research sample was determined by purposive random sampling in each swamp by observing and documenting the types of plants where fish eggs and offspring found. Determination of plant species using a plant observation guide by Dasuki (1994), Steenis (2003), and Shui (2019). Determination of the type of plant preferred by fish as a niche in laying eggs and raising offspring/fry was based on the finding eggs, offspring, and mother fish around the plants. Determination of the type of parent fish used fish observation guide by Kottelat et al. (1993), Moyle & Cech (1988), and Saanin (1984). The research data were analyzed descriptively.

RESULTS AND DISCUSSION

In our study, there were 26 species of aquatic plants used by 17 species of swamp fish to lay eggs and raise offspring/fry as shown in Table 1. The number of aquatic plants used as fish niches in this study is more than in the study conducted by Ismail et al. (2018) which only found found nine plant species, i.e., *Lemna minor*, *Polygonum barbatum*, *Eichhornia crassipes*, *Pistia stratiotes*, *Neptunia oleracea*, *Hydrilla verticillata*, *Salvinia molesta*, *Phragmites australis*, and *Azolla pinnata*.

Figure 1. Map of three research locations in three regencies in South Kalimantan Province, Indonesia: Hulu Sungai Selatan, Tanah Laut and Barito Kuala.

Tabel 1. Plant species used by fish to lay eggs and raise offspring/fry in three swamps in South Kalimantan Province

No.	Plant Species	Fish Species																
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	*Azolla pinnata*		F													F	F	
2	*Caladium* sp.		F			6				F						F		F
3	*Cyperus digitatus*	1	E	E	F	E				F			F	1		F	F	F
4	*Diplazium esculentum*	F	E	E				F						F		F		F
5	*Phaspalum conjugatum*	F		E	F	E		F		F				F			F	
6	*Eichornia crassipes*	F	E	E	F	F	E	F	F	F	E	F	F	F	F	F	F	E
7	*Hydrilla verticillata*														F			
8	*Hydrocharis Morsus*	F						F						F		F		F
9	*Hymenachne amplexicaulis*	F	E	E		E		F						F		F		E
10	*Ipomoea aquatica*		E	F	F				F	F		F			E		F	
11	*Lemna Minor*		E	E	F	E					E	F			F	F		E
12	*Lemna perpusilla*														F	F		E
13	*Limnocharis flava*	F						F		1				F		F	F	F
14	*Megathyrsus maximus*				F	F				F								
15	*Nelumbo nucifera*		F	E	F	E	E					F				F	F	F
16	*Neptunia oleracea*			F			F		F							F		E
17	*Nymphaea alba*		F	E	F						F		E		F	F		E
18	*Nymphaea lotus* L.															F		E
19	*Pistia stratoites*	F	E	F	F	E		F	F			F		F		F	F	F
20	*Salvinia minima*		E	F					F							F		F
21	*Salvinia molesta*								1	F		F			E	F	F	E
22	*Salvinia natans*		E	E		E		1	F	F						F	F	E
23	*Stenochlaena palustris*	F						F		F			F	F		F	F	F
24	*Utricularia aurea*	F	E	E	F	E		F						F		F		F
25	*Zoysia matrella*	F		F				F	F					F		F		E
26	*Crinum asiaticum*		E		F				F			F	F	F	E		F	E

Notes: E = eggs, F = fry

A	*Channa striata*	G	*Channa micropeltes*	M	*Channa lucius*
B	*Anabas testudineus*	H	*Cyprinus carpio*	N	*Rasbora argyrotaenia*
C	*Trichogaster trichopterus*	I	*Pampus argenteus*	O	*Mystus scopoli*
D	*Rasbora dusonensis*	J	*Clarias batrachus*	P	*Osteochilus hasselti*
E	*Trichogaster pectoralis*	K	*Criptopterus spp*	Q	*Oxyeleotris marmorata*
F	*Helestoma temminkii*	L	*Hemibagrus nemurus*		

Based on research conducted in April 2021, it can be seen that the presence of fish in swamp plants had two forms, namely in the form of eggs (indicated by the presence of foam around the plants) and in the form of offspring/fry (Table 1 and Figure 2). This finding suggests that the reproduction period of freshwater fish is different or happening not at the same time. This is in accordance with Setyaningrum and Wibowo (2017) who reported the reproductive ability of 5 fish species (i.c., *Cyprinus carpio*, *Barbonymus gonionatus*, *Osteochillus vittatus* *Oreochromis niloticus*, and *Clarias gariepinus*) which showed difference in reproduction period. Devkota & Kathayat (2020) explained that climate change greatly affects the reproduction, development, structure, and abundance of freshwater fish populations. In addition, the reproductive potential of fish depends on the development of the gonads until the fish spawn and produce seeds. Based on information from the people living in the three swamp areas studied, the breeding season for fish in the area indicated by the presence of fish eggs and offspring/fry is from February to August.

Niche signifies animal habitat in its biotic and abiotic environment in relation to food and its enemies (Odum, 1993). Based on this concept and Figure 3, it can be seen that the most widely used aquatic plant by fish that live in swamps as a niche for laying eggs and rearing offspring was *Eichornia crassipes* with 100% of all freshwater fish species found (17 fish species), followed by *Pistia stratoites* by 70.6% (12 fish species), *Cyperus digitatus* 52.9% (9 fish species), *Lemna minor* 52.9% (9 fish species), *Nelumbo nucifera* 52.9% (9 fish species), *Utricularia aurea* 52.9% (9 fish species), *Crinum asiaticum* 52.9% (9 fish species), *Diplazium esculentum* 47.1% (7 fish species), *Hymenachne amplexicaulis* 47.1% (8 fish species), *Ipomoea aquatica* 47.1% (8 fish species), *Nymphaea alba* 47.1% (8 fish species), *Salvinia natans* 47.1% (8 fish species), *Stenochlaena palustris* 47.1% (8 fish species), *Phaspalum conjugatum* 47, 1% (8 fish species), *Bulbostylis juncoides* 41.2% (7 fish species), *Limnocharis flava* 35.6% (6 fish species), *Salvinia molesta* 35.3% (6 species fish), *Hydrocharis morsus* 29.4% (5 fish species), *Neptunia oleracea* 29.4% (5 fish), *Salvinia minima* 29.4% (5 fish), *Caladium* sp. 23.5% (4 fish), *Azolla pinnata* 17.6% (3 fish species), *Lemna perpusilla* 17.6% (3 fish species), *Bulbostylis barbata* 17.6% (3 fish species) and *Nymphaea lotus* 11.8 % (2 fish species). Meanwhile, the plant least used by fish for laying eggs and raising offspring was *Hydrilla verticillata* with only 1 species of fish (5.9%).

Figure 2. The presence of haruan (*Channa striata*) fish eggs and offspring in aquatic plants

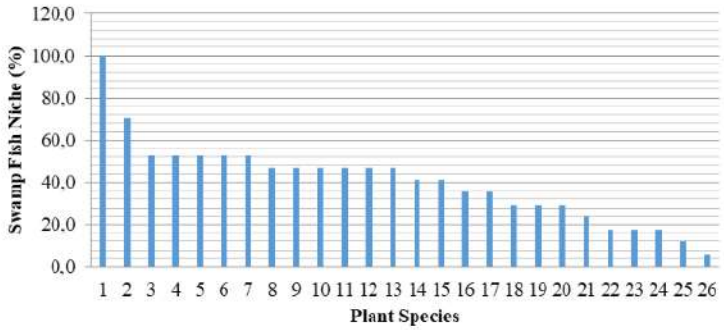

Figure 3. Percentage of fish species (of total 17 species) found in plant species in in three swamps in South Kalimantan Province

Notes:

1.	*Eichornia crassipes*	10.	*Ipomoea aquatica*	19.	*Neptunia oleracea*
2.	*Pistia stratoites*	11.	*Nymphaea alba*	20.	*Salvinia minima*
3.	*Cyperus digitatus*	12.	*Salvinia natans*	21.	*Caladium sp.*
4.	*Lemna minor*	13.	*Stenochlaena palustris*	22.	*Azolla pinnata*
5.	*Nelumbo nucifera*	14.	*Phaspalum conjugatum*	23.	*Lemna perpusilla*
6.	*Utricularia aurea*	15.	*Zoysia matrella*	24.	*Megathyrsus maximus*
7.	*Crinum asiaticum*	16.	*Limnocharis flava*	25.	*Nymphaea lotus* L.
8.	*Diplazium esculentum*	17.	*Salvinia molesta*	26.	*Hydrilla verticillata*
9.	*Hymenachne amplexicaulis*	18.	*Hydrocharis morsus*		

Based on the study results, the morphological characteristics of aquatic plants used by fish as niches for laying eggs and raising offspring/fry were related to the leaves and roots. *Eichornia crassipes* or water hyacinth was the most used plant species for niche by various types of swamp fish. *Eichornia crassipes* is a herbaceous plant with macrophyte or plant that float on water throughout its life. This plant has leaves arranged in a rosette, wide ovoid shape, which is very beneficial for fish to lay and attach eggs on a flat surface. In addition, the wide leaf will protect the eggs and offspring from the effects of direct sunlight. The water hyacinth root system is fibrous with many small, fertile and dense roots which are suitable for fish to laying eggs between these small roots. In addition, there was an abundance of organic and inorganic materials needed as food sources for young fish. The black color of the roots will protect the eggs and young fish from predators. Such morphological characteristics make this plant the most preferred by freshwater fish to lay eggs and raise their young. In this study, all the 17 freshwater species recorded in this study raise their juveniles around *Eichornia crassipes*. Our finding that *Eichornia crassipes* serves as a niche for fish reproduction is in line with other studies, such as Whetstone (2009), Gettys (2009), and Ismail et al. (2018).

Pistia stratoites has a single leaf type with dense leaves arrangement and dense rosettes, the leaves have spoon shape, the edges of the leaves are grooved with a smooth leaf surface and hairy stripes, the texture of the leaves is thick and soft with a length of 1.3-10 cm and a width of 1.5-6 cm. Such leaf morphology is very beneficial for fish to attach or lay eggs. In addition, the dense leaf blades or rosettes will protect the eggs and offspring from the effects of sunlight and water currents. However, the roots of this plant is at the bottom of the water, so fish cannot use it to attach or lay eggs.

In contrast, *Rasbora argyrotaenia* was found only in *Hydrilla verticillat*a which uses this plant to lay eggs and raise their young. *Hydrilla verticillata* is a herbaceous plant that lives in tightly spreading water. It has stems intercalated 0.7 cm-1.4 cm with single leaf lanceolate in shape and arranged at a circular layout of 3-6 leaves, leaf margins are serrated, leaf surface with a length of 0.6-2.5 cm and a width of 1.2-5.5 cm. The root system of this plant is fibers attached at the bottom of the water. Based on these morphological characteristics, the potential of plants as a niche for laying eggs and raising offspring is only in its leaves. In addition, with a dense habitus, it will be an obstacle for medium and large-sized fish for their reproductive purposes. So that only small fish can use this plant to lay eggs and raise juveniles, which in this study was *Rasbora argyrotaenia*. Another study also found *Hydrilla verticillata* as a fish niche was also reported by Ismail et al. (2018).

Based on the description above, the morphological characteristics of shape, size and number of leaves that float on the surface, and the shape and number of root fibers affected the presence of freshwater fish to lay eggs and maintain their juveniles. The larger the leaf size, the higher the number of leaves that cover the water surface, the rougher the leaf surface and edges, and the denser the root system in the water (not in the soil), the more fish is likely to lay eggs and raise young around plants with such characteristics. In addition, such morphological characteristics also will slow and calm the flow of water currents, making it suitable for laying eggs and raising fish. The dense roots in the water can hold and bind the minerals and organic matters which might be beneficial for feeding the young fish. Aquatic plants with broad leaves have an important role as oxidizing agents, so they are very efficient in binding carbon dioxide in the water and releasing it into oxygen which is beneficial for young fish.

The concept of weeds in swamp habitat if viewed from the importance of maintaining fish diversity might not be relevant because swamp habitat is not an area used for productive plant cultivation. The existence of aquatic plants in the swamp habitat needs to be maintained so that the freshwater fish required by the people living in the area can always be maintained and used as a source of natural animal protein. Triyanto et al. (2019), Lende & Khileri (2021) found that fish use aquatic plants to lay eggs and reproduce on the leaf surface of aquatic plants. Thus, plant species that important as habitat niche of swamp fish need to be maintained and controlled. According to Fuller et al. (1998), integrating vegetation cover and other biodiversity such as fish can assist conservation planning.

In addition, we found that each fish that lived in the swamp never used one plant simultaneously with other fishes to raise young at the same time and place. Thus, one plant is only used by one type of fish in each spawning. The diversity of aquatic plant species in swamps affects swamp fish species' activity, growth, and territorial formation. This is in line with the concept of there is no two species use the same resources simultaneously Odum, 1993) which is also true for fish using aquatic plants as niches to lay eggs and raise their young. Thus it can be said that fish choose certain plants to lay their eggs and raise their young precisely without the presence of other fish to do the same. Research by Mouton et al. (2010) shows that differences in life histories or even gene flow of fish

assemblages can result in different realization niches. Haller (2009), Costa et al. (2010) and Ismail et al. (2018) stated that the abundance of aquatic plants triggers the growth and condition of fish. The limitations and excess of aquatic plants in swamp areas can reduce the abundance of fish. According to (Mirmanto 2009), the negative correlation is the existence of competition between individual seeds at the beginning of growth, not between species.

Based on the description above, it can be stated that the more aquatic plants found in the swamp will make the swamp an optimal fish niche for fish to lay eggs and raise young. This will have a positive impact on the diversity of fish in the swamp. Therefore, the existence of these plants needs to be maintained and their fertility increased to ensure the development of freshwater fish, especially those that live in swamps.

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Aquatic plants as niche for lay eggs and raising juveniles by freshwater fish in three swamp habitats in South Kalimantan, Indonesia

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Abstract. *Dharmono, Mahrudin, Irianti R, Fajeriadi H. 2022. Aquatic plants as niche for lay eggs and raising juveniles by freshwater fish in three swamp habitats in South Kalimantan, Indonesia. Biodiversitas 23: 1520-1526.* Swamp is an area that is almost always waterlogged throughout the year, making it a very unique ecosystem. There is a wide variety of ecosystem services provided by swamp ecosystems, one of those is a habitat of freshwater fish, which is related to the presence of swamp vegetation. This study aimed to investigate swamp plants used as niches for freshwater fish to lay eggs and raise its offspring in three swamp areas in three regencies (i.e., Hulu Sungai Utara Regency, Tanah Laut Regency and Barito Kuala Regency) in South Kalimantan Province, Indonesia. Purposive random sampling was conducted in each swamp by observing and documenting the types of plants where fish eggs and offspring were found. We recorded 26 species of aquatic plants used by 17 species of swamp fish to lay eggs and raise offspring/fry. *Eichhornia crassipes* was the most widely used aquatic plant species with 100% of all freshwater fish species found (17 fish species), followed by *Pistia stratiotes* by 70.6% (12 fish species) and *Cyperus digitatus*, *Lemna minor*, *Nelumbo nucifera*, *Utricularia aurea* and *Crinum asiaticum* with each used by 52.9% (9 fish species). These plant species favored by fish need to be maintained and controlled to support the population of the fish.

Keywords: Swamp plants, stand and raise, young fish

INTRODUCTION

Based on the 1971 Ramsar Convention, a swamp is defined as an area that is almost always waterlogged throughout the year, naturally formed on relatively flat or sunken land with mineral deposits or peat and overgrown with vegetation (Matthews 2013). Swamps are waterlogged, acidic, anoxic, and oligotrophic ecosystems (Too et al. 2021). Swamps ecosystems as floodplain areas provide a wide variety of ecosystem services (Phiri et al. 2021), including maintaining hydrological and carbon cycles between land and atmosphere (Ohkubo et al. 2021), medium of seeds distribution (Lei and Middleton 2021), and the habitat of aquatic plants and animals (Padil et al. 2021). For example, a study in the Tripa peat swamp forest, Indonesia, recorded 41 species of herbaceous plants (Djufri et al. 2016).

Despite their importance, in the last decades, swamp ecosystems, particularly in the tropics, have been pressured by various human activities such as logging, deforestation and degradation, and land conversion, making it prone to large fires, especially during the dry season (Kubik et al. 2020). This phenomenon causes changes in the environment and climate (Lei and Middleton 2021), thus affecting the carbon cycle of the swamp ecosystem (Liu et al. 2020) and threatening its biodiversity, including the vegetation (Paul et al. 2020). The continuing habitat loss in the swamp ecosystem could result in biodiversity loss before it is known their species diversity (Barletta et al. 2010). Therefore, prudent management of aquatic habitats, including swamp ecosystems, is needed to conserve aquatic biodiversity (Ndehedehe et al. 2020)

Peat swamp ecosystem is one of the unique habitats that has high species endemism (Joni et al. 2015). Different vegetation in this ecosystem indicates niche formation due to unique biotic and abiotic factors, which are mainly caused by the waterlogged condition and highly acidic water and soils. However, small-scale spatial variations show the stochastic nature of the vegetation (DiMichele et al. 2017). Niche area and trophic diversity can indicate resource use according to trophic availability, regardless of size or sex (Correia 2002). For instance, ridge-hollow swamps can generate ecological niches in strongly acidic aqueous media with specific aquatic plants and animals that may live in the area (Rybina et al. 2014). According to Kłosowski and Jabłońska (2009), habitat conditions in water bodies are distinguished based on the dominance of aquatic plant species associated with particular habitats. For example, bitter-fruited and sweet-fruited vegetation might require different ecological niches (Vihotogbé et al. 2019).

Whetstone (2009) states that vegetation occurring in the swamp ecosystem can be classified into three groups, namely surface plants, floating plants, and submerged plants. Surface plants have roots at the bottom of the water with leaves extending upward to the water surface, for example, *Sagittaria sinensis* and *Phragmites communis*. Meanwhile, Goel (2006) stated that floating plants are

plants whose roots hang in the water or do not touch the bottom of the water, for example, *Nymphaea* sp. and *Nelumbo* sp. Submerged plants are plants that live entirely in water, such as *Hydrilla verticillata*, *Najas minor*, *Chara vulgaris* and *Ceratophyllum demersum*.

Aquatic plants in the swamp ecosystem play an essential role in fish life (Kurniawan and Paramita 2019). Aquatic animals such as fish are very dependent on the presence of plants that live in swamps as a niche or micro-habitat, especially for shelter and breeding (Raharjo 2018). The abundance of aquatic plants is positively correlated with fish populations (Odum 1993). Habitats with moderate amounts of aquatic plants provide an optimal environment for many fish to increase fish diversity, feeding, growth, and reproduction. In contrast, limited or excessive vegetation cover can reduce the growth rate of fish by 75% to 85% (Ismail et al. 2018). Fish uses aquatic plants to lay eggs on the leaf surface of aquatic plants or among smooth-leaved plants on mangrove vegetation (Triyanto et al. 2019). For example, the parent fish *Clarias batrachus* and fish *Melanotaenia* sp. usually form pairs, lay eggs, and protect eggs and seeds from harm under aquatic plants (Lende and Khileri 2021).

Each type of plant has specific morphological characteristics to adapt with its habitat (Steenis 2013). In the swamp ecosystem, the morphological characteristics of swamp vegetation are thought to be used by freshwater fish species as living and growing habitats. Based on the research results of Ismail et al. (2018), no research results have been found that report certain types of plants selected by certain types of fish as a niche for laying eggs and raising its offspring. In addition, the types of plants favored by fish need to be maintained, and their fertility needs to be increased.

This study aimed to investigate swamp plants used as niches for freshwater fish to lay eggs and raise its offspring in three swamp areas in South Kalimantan Province, Indonesia. The swamps in South Kalimantan, or locally called *lebak*, provide an excellent study context since the province has a swamp area of 208.893 ha with vegetation dominated by shrubs and shrubs. We expect the results of this study can be disseminated to the people living around the swamps through raising awareness about the potential uses, threats, and conservation of swamps, especially the influence of aquatic plants on the presence of freshwater fish in swamp habitats, and even deliberately restore the degraded swamp to increase fish population.

MATERIALS AND METHODS

Study area and period

This research was carried out in three swamp habitats in South Kalimantan, Indonesia, namely Rawa Hulu Sungai Utara Regency, Rawa Tanah Laut Regency, and Barito Kuala Regency in April 2021 (Figure 1). The research site in Hulu Sungai Utara Regency is located at the coordinates of 2°36'17.10" South latitude and 115°5'54.59" East longitude at an altitude of 15-17 m above sea level (asl) with temperatures ranging from 21-35ºC and an average rainfall of 384.5 mm/year. The area of the swamp studied was 92.5 ha in the form of a lowland swamp influenced by tidal river water and rainwater with a diversity of flora dominated by aquatic herbaceous plants of Hydrocharitaceae, Cyperaceae, and Poaceae. The people who live around the swamp are farmers, swamp buffalo breeders and fishermen.

The research site in Tanah Laut Regency is located at the coordinates of 114.583° - 114.711° East longitude and 3.56309° - 3.72364° South latitude at an altitude of ±0.5-1 m asl with temperatures ranging from 21-36°C and an average rainfall of 203.8 mm/year. The area of the swamp studied was 56.7 ha in the form of a mangrove swamp, which was influenced by tides of seawater and river water with a salinity of 0-7 ppm. The diversity of flora was dominated by aquatic herbaceous plants in the form of Mangroves, Hydrocharitaceae, Cyperaceae, and Poaceae. The people who live around the swamp are farmers and fishermen.

The research site in Barito Kuala Regency is located at the coordinates of 3°15'25" - 3°20'72" South latitude and 114°38'28" - 114°68'17" East longitude at an altitude of ±0.5-1 m asl with a temperature range from 23-35°C and the average rainfall was 248.23 mm/year. The area of the swamp studied is 47.2 ha in the form of a monton swamp which is inundated throughout the year. Diversity of flora dominated by aquatic herbaceous plants in the form of Hydrocharitaceae, Cyperaceae, Poaceae, and Myrtaceae. The people living around the swamp are farming communities, seekers of galam wood and fishermen.

Data collection procedure

This research used observational techniques with descriptive analysis. The research sample was determined by purposive random sampling in each swamp by observing and documenting the types of plants where fish eggs and offspring were found. Determination of plant species using a plant observation guide by Dasuki (1994), Steenis (2013), and Shui (2019). Determination of the type of plant preferred by fish as a niche in laying eggs and raising offspring/fry was based on the finding eggs, offspring, and mother fish around the plants. Determination of the type of parent fish used fish observation guide by Saanin (1984), Moyle and Cech (1988) and Kottelat et al. (1993). The research data were analyzed descriptively.

RESULTS AND DISCUSSION

In our study, there were 26 species of aquatic plants used by 17 species of swamp fish to lay eggs and raise offspring/fry, as shown in Table 1. The number of aquatic plants used as fish niches in this study is more than in the study conducted by Ismail et al. (2018), which only found nine plant species, i.e., *Lemna minor*, *Polygonum barbatum*, *Eichhornia crassipes*, *Pistia stratiotes*, *Neptunia oleracea*, *Hydrilla verticillata*, *Salvinia molesta*, *Phragmites australis*, and *Azolla pinnata*.

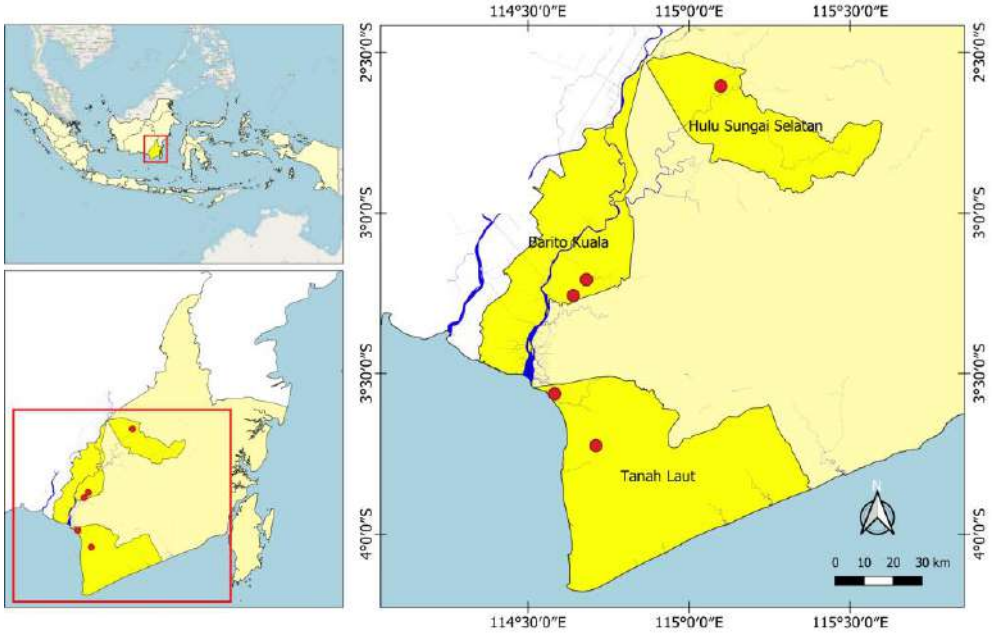

Figure 1. Map of three research locations in three regencies in South Kalimantan Province, Indonesia: Hulu Sungai Selatan, Tanah Laut and Barito Kuala.

Tabel 1. Plant species used by fish to lay eggs and raise offspring/fry in three swamps in South Kalimantan Province, Indonesia

No.	Plant species	Fish species																
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**
1	*Azolla pinnata*		F													F	F	
2	*Caladium* sp.		F							F						F		F
3	*Cyperus digitatus*		E	E	F	E				F			F			F	F	F
4	*Diplazium esculentum*	F	E	E				F						F		F		F
5	*Phaspalum conjugatum*	F		E	F	E		F		F				F			F	
6	*Eichornia crassipes*	F	E	E	F	F	E	F	F	F	E	F	F	F	F	F	F	E
7	*Hydrilla verticillata*														F			
8	*Hydrocharis Morsus*	F						F						F		F		F
9	*Hymenachne amplexicaulis*	F	E	E		E		F						F		F		E
10	*Ipomoea aquatica*		E	F	F				F	F		F			E		F	
11	*Lemna Minor*		E	E	F	E					E	F			F	F		E
12	*Lemna perpusilla*														F	F		E
13	*Limnocharis flava*	F						F						F		F	F	F
14	*Megathyrsus maximus*				F	F				F								
15	*Nelumbo nucifera*		F	E	F	E	E					F				F	F	F
16	*Neptunia oleracea*			F			F		F							F		E
17	*Nymphaea alba*		F	E	F						F		E		F	F		E
18	*Nymphaea lotus*															F		E
19	*Pistia stratiotes*	F	E	F	F	E		F	F			F		F		F	F	F
20	*Salvinia minima*		E	F					F							F		F
21	*Salvinia molesta*									F		F			E	F	F	E
22	*Salvinia natans*		E	E		E			F	F						F	F	E
23	*Stenochlaena palustris*	F						F		F			F	F		F	F	F
24	*Utricularia aurea*	F	E	E	F	E		F						F		F		F
25	*Zoysia matrella*	F		F				F	F					F		F		E
26	*Crinum asiaticum*		E		F				F			F	F	F	E		F	E

Notes: E = eggs, F = fry

A	*Channa striata*	G	*Channa micropeltes*	M	*Channa lucius*
B	*Anabas testudineus*	H	*Cyprinus carpio*	N	*Rasbora argyrotaenia*
C	*Trichogaster trichopterus*	I	*Pampus argenteus*	O	*Mystus scopoli*
D	*Rasbora dusonensis*	J	*Clarias batrachus*	P	*Osteochilus hasselti*
E	*Trichogaster pectoralis*	K	*Criptopterus* spp	Q	*Oxyeleotris marmorata*
F	*Helostoma temminckii*	L	*Hemibagrus nemurus*		

Based on research conducted in April 2021, it can be seen that the presence of fish in swamp plants had two forms, namely in the form of eggs (indicated by the presence of foam around the plants) and in the form of offspring/fry (Table 1 and Figure 2). This finding suggests that the reproduction period of freshwater fish is different or happening not at the same time. This is in accordance with Setyaningrum and Wibowo (2017) who reported the reproductive ability of 5 fish species (i.e., *Cyprinus carpio, Barbonymus gonionatus, Osteochilus vittatus, Oreochromis niloticus,* and *Clarias gariepinus*), which showed a difference in reproduction period. Devkota and Kathayat (2020) explained that climate change greatly affects the reproduction, development, structure, and abundance of freshwater fish populations. In addition, the reproductive potential of fish depends on the development of the gonads until the fish spawn and produce seeds. Based on information from the people living in the three swamp areas studied, the breeding season for fish in the area indicated by the presence of fish eggs and offspring/fry is from February to August.

Niche signifies animal habitat in its biotic and abiotic environment in relation to food and its enemies (Odum 1993). Based on this concept and Figure 3, it can be seen that the most widely used aquatic plant by fish that live in swamps as a niche for laying eggs and rearing offspring was *Eichornia crassipes* with 100% of all freshwater fish species found (17 fish species), followed by *Pistia stratiotes* by 70.6% (12 fish species), *Cyperus digitatus* 52.9% (9 fish species), *Lemna minor* 52.9% (9 fish species), *Nelumbo nucifera* 52.9% (9 fish species), *Utricularia aurea* 52.9% (9 fish species), *Crinum asiaticum* 52.9% (9 fish species), *Diplazium esculentum* 47.1% (7 fish species), *Hymenachne amplexicaulis* 47.1% (8 fish species), *Ipomoea aquatica* 47.1% (8 fish species), *Nymphaea alba* 47.1% (8 fish species), *Salvinia natans* 47.1% (8 fish species), *Stenochlaena palustris* 47.1% (8 fish species), *Paspalum conjugatum* 47.1% (8 fish species), *Bulbostylis juncoides* 41.2% (7 fish species), *Limnocharis flava* 35.6% (6 fish species), *Salvinia molesta* 35.3% (6 species fish), *Hydrocharis morsus* 29.4% (5 fish species), *Neptunia oleracea* 29.4% (5 fish), *Salvinia minima* 29.4% (5 fish), *Caladium* sp. 23.5% (4 fish), *Azolla pinnata* 17.6% (3 fish species), *Lemna perpusilla* 17.6% (3 fish species), *Bulbostylis barbata* 17.6% (3 fish species) and *Nymphaea lotus* 11.8 % (2 fish species). Meanwhile, the plant least used by fish for laying eggs and raising offspring was *Hydrilla verticillata*, with only 1 species of fish (5.9%).

Based on the study results, the morphological characteristics of aquatic plants used by fish as niches for laying eggs and raising offspring/fry were related to the leaves and roots. *Eichhornia crassipes* or water hyacinth was the most used plant species for niche by various types of swamp fish. *Eichhornia crassipes* is herbaceous plant with macrophytes or plants that float on water throughout its life. This plant has leaves arranged in a rosette, wide ovoid shape, which is very beneficial for fish to lay and attach eggs on a flat surface. In addition, the wide leaf will protect the eggs and offspring from the effects of direct sunlight. The water hyacinth root system is fibrous with many small, fertile and dense roots, which are suitable for fish to lay eggs between these small roots. In addition, there was an abundance of organic and inorganic materials needed as food sources for young fish. The black color of the roots will protect the eggs and young fish from predators. Such morphological characteristics make this plant the most preferred by freshwater fish to lay eggs and raise their young. In this study, all the 17 freshwater species recorded in this study raise their juveniles around *Eichhornia crassipes*. Our finding that *Eichhornia crassipes* serve as a niche for fish reproduction is in line with other studies, such as Ismail et al. (2018), Gettys (2009) and Whetstone (2009).

Figure 2. The presence of haruan (*Channa striata*) fish eggs and offspring in aquatic plants

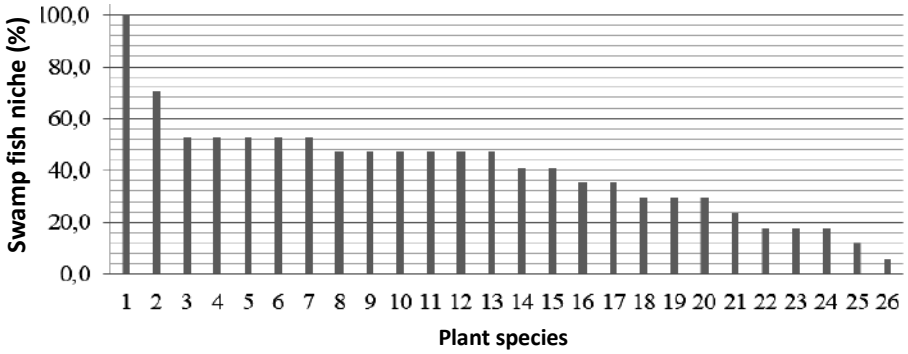

Figure 3. Percentage of fish species (of total 17 species) found in plant species in in three swamps in South Kalimantan Province

Note:

1. *Eichhornia crassipes*
2. *Pistia stratiotes*
3. *Cyperus digitatus*
4. *Lemna minor*
5. *Nelumbo nucifera*
6. *Utricularia aurea*
7. *Crinum asiaticum*
8. *Diplazium esculentum*
9. *Hymenachne amplexicaulis*
10. *Ipomoea aquatica*
11. *Nymphaea alba*
12. *Salvinia natans*
13. *Stenochlaena palustris*
14. *Paspalum conjugatum*
15. *Zoysia matrella*
16. *Limnocharis flava*
17. *Salvinia molesta*
18. *Hydrocharis morsus*
19. *Neptunia oleracea*
20. *Salvinia minima*
21. *Caladium* sp.
22. *Azolla pinnata*
23. *Lemna perpusilla*
24. *Megathyrsus maximus*
25. *Nymphaea lotus*
26. *Hydrilla verticillata*

Pistia stratiotes has a single leaf type with dense leaves arrangement and dense rosettes, the leaves have spoon shape, the edges of the leaves are grooved with a smooth leaf surface and hairy stripes, the texture of the leaves is thick and soft with a length of 1.3-10 cm and a width of 1.5-6 cm. Such leaf morphology is very beneficial for fish to attach or lay eggs. In addition, the dense leaf blades or rosettes will protect the eggs and offspring from the effects of sunlight and water currents. However, the roots of this plant is at the bottom of the water, so fish cannot use it to attach or lay eggs.

In contrast, *Rasbora argyrotaenia* was found only in *Hydrilla verticillata* which uses this plant to lay eggs and raise their young. *Hydrilla verticillata* is herbaceous plant that lives in tightly spreading water. It has stems intercalated 0.7 cm - 1.4 cm with single leaf lanceolate in shape and arranged at a circular layout of 3-6 leaves, leaf margins are serrated, leaf surface with a length of 0.6-2.5 cm and a width of 1.2-5.5 cm. The root system of this plant is fibers attached at the bottom of the water. Based on these morphological characteristics, the potential of plants as a niche for laying eggs and raising offspring is only in its leaves. In addition, with a dense habitus, it will be an obstacle for medium and large-sized fish for their reproductive purposes. So that only small fish can use this plant to lay eggs and raise juveniles, which in this study was *Rasbora argyrotaenia*. Another study also found *Hydrilla verticillata* as a fish niche was also reported by Ismail et al. (2018).

Based on the description above, the morphological characteristics of shape, size and number of leaves that float on the surface and the shape and number of root fibers affected the presence of freshwater fish to lay eggs and maintain their juveniles. The larger the leaf size, the higher the number of leaves that cover the water surface, the rougher the leaf surface and edges, and the denser the root system in the water (not in the soil), the more fish is likely to lay eggs and raise young around plants with such characteristics. In addition, such morphological characteristics also will slow and calm the flow of water currents, making it suitable for laying eggs and raising fish. The dense roots in the water can hold and bind the minerals and organic matters, which might be beneficial for feeding young fish. Aquatic plants with broad leaves have an important role as oxidizing agents, so they are very efficient in binding carbon dioxide in the water and releasing it into oxygen which is beneficial for young fish.

The concept of weeds in swamp habitat, if viewed from the importance of maintaining fish diversity, might not be relevant because swamp habitat is not an area used for productive plant cultivation. The existence of aquatic plants in the swamp habitat needs to be maintained so that the freshwater fish required by the people living in the area can always be maintained and used as a source of natural animal protein. Triyanto et al. (2019), Lende and Khileri (2021) found that fish use aquatic plants to lay eggs and reproduce on the leaf surface of aquatic plants. Thus, plant species that important as habitat niches of swamp fish need to be maintained and controlled. According to Fuller et al. (1998), integrating vegetation cover and another biodiversity such as fish can assist conservation planning.

In addition, we found that each fish that lived in the swamp never used one plant simultaneously with other fishes to raise young at the same time and place. Thus, one plant is only used by one type of fish in each spawning. The diversity of aquatic plant species in swamps affects swamp fish species' activity, growth, and territorial formation. This is in line with the concept of there is no

two species use the same resources simultaneously (Odum 1993), which is also true for fish using aquatic plants as niches to lay eggs and raise their young. Thus it can be said that fish choose certain plants to lay their eggs and raise their young precisely without the presence of other fish to do the same. Research by Mouton et al. (2010) shows that differences in life histories or even gene flow of fish assemblages can result in different realization niches. Haller (2009), Costa et al. (2010) and Ismail et al. (2018) stated that the abundance of aquatic plants triggers the growth and condition of fish. The limitations and excess of aquatic plants in swamp areas can reduce the abundance of fish. According to (Mirmanto 2009), the negative correlation is the existence of competition between individual seeds at the beginning of growth, not between species.

Based on the description above, it can be stated that the more aquatic plants found in the swamp will make the swamp an optimal fish niche for fish to lay eggs and raise young. This will have a positive impact on the diversity of fish in the swamp. Therefore, the existence of these plants needs to be maintained and their fertility increased to ensure the development of freshwater fish, especially those that live in swamps.

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