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ECOLOGICAL AND MORPHOLOGICAL STUDY ON FISH-FAUNA FROM THE WATERS AROUND TAIWAN AND ITS ADJACENT ISLANDS

1. Notes on clingfishes and its distributions

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ABSTRACT

Shih-Chien Shen (1971). *Ecological and Morphological Study on Fish-Fauna from the Waters Around Taiwan and its Adjacent Islands.* Bull. Inst. Zool., Academia Sinica **10**(2): 83-95. The clingfishes of the family Gobiesocidae were reviewed from Taiwan. Three species are recognized: *Conidens laticephalus* (TANAKA), 1909, *Aspasma minima* (Döderlein), 1887, and *Lepadichthys frenatus* Waite, 1904, in which *C. laticephalus* and *Aspasma minima* are new to Taiwan, *L. frenatus* and *C. laticephalus* are very common, and all of three restricted to the Northern and North-eastern parts of Taiwan.

The purpose of the present study is to review the status of the fish-fauna distributed around the waters of Taiwan and its adjacent islands by extensive and intensive collection, but it is also the initial work of a part of the biological resources in national oceanic resources development plan and an attempt to resume the interrupted work since World War II. Although some scientists have been doing the taxonomic work on fishes in recent years, especially Prof. Johnson T. F. Chen who has dedicated his life to build the ground work for the taxonomy of the vertebrates in Taiwan, it seems that the ecological and morphological studies of the fish-fauna are more necessary. Therefore, the present work emphasizes this point and under the financial support from the National Science Committee we have collected fish specimens extensively and intensively along the coast all year round since 1968. A large number of species were collected during the past few years and quite a large volum of data will be published. For the sake of convenience it will be published serially by family or group just as the present report.

The clingfishes are small teleostean fishes that occur in shallow coastal waters and often in the intertidal zone. There are six nominal species and six nominal genera described from the Indo-Pacific region: *Conidens laticephalus* (Tanaka), 1909, *Lepadichtys frenatus* Waite, 1904, *Aspasma minima* (Döderlein), 1887, *Aspasmichtys ciconae* (Jordan & Fowler), 1902, *Pherallodus indicus* (Weber), 1913 and *Diademichtys lineatus* (Sauvage), 1883. However, only the first three species occur

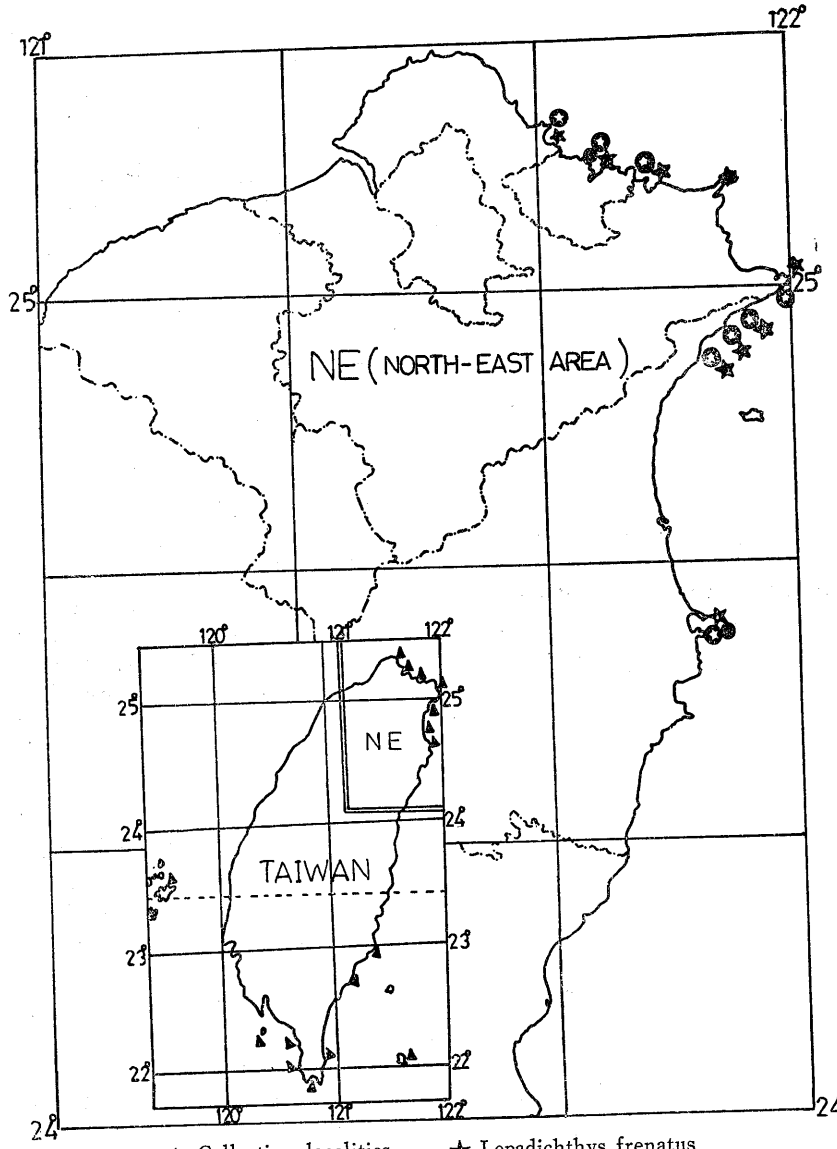

Fig. 1. Showing the collecting localities and the distributions of three species.

in Taiwan and are almost entirely restricted to the Northern and North-eastern part of Taiwan (Fig. 1), the first four species are widely spread from Okinawa to Southern Japan, (Fig. 2), L. frenatus only spreads from Southern Japan to Philippines, Borneo and even Australia.

MATERIALS AND METHODS

Materials used for the present study were new collections deposited in the Museum of the Institute of Zoology, Academia Sinica. A large number of specimens were radiographed and data on the various meristic

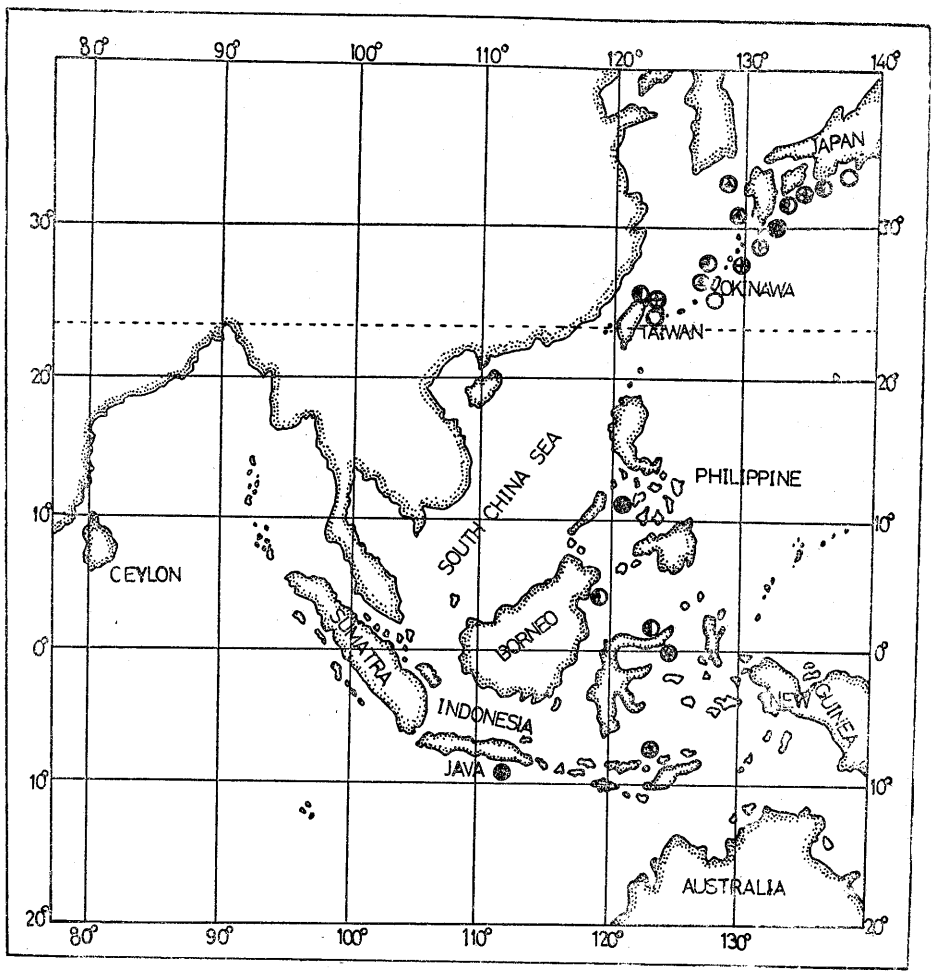

Fig. 2. Showing the Genera of the family Gobiesocidae distributed in indo-pacific region.

characters were obtained from the study of the films. Other specimens were cleared and stained using Taylor's (18) enzyme method. Measurements were made with needle-point dividers as follows—standard length from snout tip to median caudal fin base; depth of the body taken at the origin of the dorsal fin; snout length from the snout tip to the anterior most margin of the orbit; head= width taken in the region of preopercles; eye diameter which is the greatest diameter (bony) of the orbit; postorbital from the posterior margin of the orbit to the posterior-most margin of the opercle; tip-D which is the distance from the snout tip to the origin of the dorsal fin; tip-A, the distance from snout tip to the origin of the anal fin; interorbital, which refers to the bony inter-orbital distance; and disc length which is the longitudinal distance between the outermost edges of the thin membrane surrounding the heavier portions of the disc. The terminology

and methods used follow those described by Briggs (2) except for the above mentioned ones.

The rays of the dorsal, anal and caudal fins were counted by using the X-ray films or the cleared and stained specimens.

All measurements were expressed in both relative proportions and percentages.

Key to species of Gobiesocidae

A_1. Gill membrane free from isthmus; color very dark, usually blackish or brownish and with dark brown vertical bands on body. Vertebral number 12−13+15−17 =27−30..... ..... *Conidens laticephalus* (TANAKA).

A_2. Gill membrane attached to isthmus; color light yellow, or yellow.

B_1. Dorsal rays 6-7; anal 6; dorsal and anal fin not united with caudal; ventral disc double type; vertebral number 14−15+17−18=31−33..... ..... *Aspasma minima* (Döderlein).

B_2. Dorsal rays 17-18, anal 14; dorsal and anal fins united with caudal fin; ventral disc single type; vertebral number 17+17−18=34−35..... ..... *Lepadichthys frenatus* Waite.

Conidens laticephalus (TANAKA).
(Fig. 3-5, Table 1)

Aspasma laticephala Tanaka, 1909, p. 25; Jordan, Tanaka and Snyder, 1913, p. 378; Okada, Uchida, and Matsubara, 1935, p. 249; Okada and Matsubara, 1938, p. 378; Okada, 1938, p. 249; Matsubara 1955, p. 1216; Uchida, 1966, p. 507; Okada and Uchida, 1965, p. 483.

Conidens laticephalus Briggs, 1955, p. 17; Tomiyama, Abe and Tokioka, 1964, p. 85; Okada, Uchida and Uchida, 1968, p. 483; Uchida and Matsubara 1966, p. 509.

DIAGNOSIS: A comparatively large species which is heavily pigmented and retains the dark brown or brown color in formalin or alcohol. The dorsal and anal fins are not united with the caudal fin, but are connected with the caudal peduncle by a membrane. These are based on 38 specimens, 18.8-40.7 mm in standard length. They were collected from North and North-eastern part of Taiwan.

DESCRIPTION: Dorsal fin 8-9; anal fin 6; pectoral fin 20; caudal fin rays 13-16; vertebral number 12−13+15−17=27−30.

Measurements (Number of times contained in SL, and percent in parentheses): Head 2.2-2.7 (37.9-49.7); depth 5.2-6.9 (11.2-19.0); depth of head 5.5-6.9 (11.2-18.1); tip of snout to dorsal origin 1.3-1.9 (69.5-79.1), to anal origin 1.2-1.8 (74.1-85.2), to ventral origin 2.9-3.9 (25.5-34.4), to pectoral origin 2.3-2.8 (36.6-43.9).

Measurements (Number of times contained in head length, and percent in parentheses): snout length 3.3-4.8 (19.1-30.2); eye 3.6-4.9 (20.7-27.6); interorbital 4.0-5.9 (16.2-25.0); postorbital 1.8-2.2 (47.6-56.9); width of head 1.3-1.9 (52.0-80.0); disc length 1.1-1.6 (61.1-92.5); longest dorsal ray 3.1-5.8 (18.3-31.9); longest anal ray 3.1-5.9 (16.8-30.6); longest pectoral ray 2.0-2.9 (34.5-50.0); dorsal base 1.4-2.1 (47.3-69.0); anal base 1.9-3.0 (33.3-55.2).

The body is wide medially, fairly well depressed anteriorly, compressed at the caudal part, and naked but with small tubercles. The head is medium and well depressed. The mouth is terminally and slightly oblique. The maxillae end below the anterior margin of the eye. The length of the lower jaw equal to that of the upper jaw. The teeth are conical, pointed depressible in a single row on both jaws. The snout is longer than the eye. Two tubular nostrils are present on each side. The interorbital space is wide. It is slightly convex and is about equal or a little longer than the diameter of the eye. The dorsal fin is about or slightly anterior to the level of

the anus. The anal fin is about ½ diameter of eye behind anus. The tips of the depressed, last dorsal and anal rays do not or reach the caudal fin base, but are connected with the caudal peduncle by a membrane. The pecotal fins are round and are connected with the posterior margin of the anterior disc by a membrane. The pelvic fins are incorporated into a prominent adhesive double type disc with papillae distributed over most of its surface as shown in Fig. 5. Four rays of each ventral fin form the posterior edge of the anterior disc with the last ray having a membrane connected to the lower margin of the pectoral fin. The

TABLE 1
Counts and Measurements of *Conidens laticephalus* (TANAKA).

Count or Measurement	Range		Number of Indiv.	Mean	
	Proportion	Percent		Proportion	Percent
Total length (mm)	23.6-48.5		38		
Standard length (mm)	18.8-40.7		38		
Dorsal fin	8-9		38	8.11	
Anal fin	6		38	6	
Pectoral fin	20		38	20	
Pelvic fin	4		38	4	
Vertebral number	12—13+15—17=27—30		38		
In Standard length or Percent of Standard length:					
Head length	2.2-2.7	37.9-49.7	38	2.4	40.9
Body depth	5.2-6.9	11.2-19.2	38	6.1	16.5
Height of head	5.5-6.9	11.2-18.2	38	6.4	15.2
Dist. from tip of snout to:					
Dorsal origin	1.3-1.9	69.5-79.1	38	1.3	74.3
Anal origin	1.2-1.8	74.1-85.2	38	1.2	79.9
Disc origin	2.9-3.9	25.6-34.4	38	3.3	31.3
Pectoral origin	2.3-2.8	36.6-43.9	38	2.5	43.1
In Head length or Percent of Head length:					
Snout length	3.3-4.8	19.1-30.2	38	4.2	23.9
Diameter of eye	3.6-4.9	20.7-27.6	38	4.3	23.4
Interorbital	4.0-6.0	16.2-25.0	38	4.9	20.4
Post orbital	1.8-2.2	47.6-56.9	38	1.9	52.7
Longest dorsal ray	3.1-5.8	18.3-31.9	38	4.2	25.3
Dorsal base	1.4-2.1	47.3-69.0	38	1.7	60.2
Longest anal ray	3.1-5.9	16.8-30.6	38	4.5	22.4
Anal base	1.9-3.0	33.3-55.2	38	2.4	42.2
Longest pectoral ray	2.0-2.9	34.5-50.0	38	2.5	39.7
Disc length	1.1-1.6	61.1-92.5	38	1.3	75.6

anterior free edge of the posterior disc extends dorsally behind the pectoral fin to form a well developed dermal flap. The caudal fin is round. The gill membranes are free from isthmus. The upper attachment of the gill membrane is opposite 2-4 pectoral rays. The axial dermal flap is opposite 11-12 pectoral rays.

The color in formalin is brown or dark brown with black lines forming a network on the dorsal surface of the head (Fig. 4) and with vertical lines on both sides of the body. The color of the fresh specimens is usually dark gray with a thin mucous coat.

TABLE 2
Counts and Measurements of *Aspasma minima* (Döderlein).

Count or Measurement	Range		Number of Indiv.	Mean	
	Proportion	Percent		Proportion	Percent
Total length (mm)	21.1-28.8		4		
Standard length (mm)	18.5-25.6		4		
Dorsal fin	6-7		4	6.8	
Anal fin	6		4	6	
Pectoral fin	20		4	20	
Pelvic fin	4		4	4	
Vertebral number	14—15+17—18=31—33		4		
In Standard length or Percent of Standard lenght:					
Head length	2.8-3.2	30.9-36.3	4	3.1	32.9
Body depth	6.4-7.5	13.4-15.6	4	6.9	14.5
Height of head	7.5-8.4	11.9-13.3	4	7.9	12.7
Dist. from tip of snout to:					
Dorsal origin	1.3-1.5	69.1-70.3	4	1.4	70.0
Anal origin	1.3-1.5	65.0-77.0	4	1.4	72.9
Disc origin	3.1-4.5	24.7-31.9	4	3.6	28.1
Pectoral origin	3.2-3.5	28.8-31.9	4	3.4	29.7
In Head length or Percent of Head length:					
Snout length	3.3-4.9	20.5-26.4	4	4.1	24.4
Eye diameter	4.0-5.5	18.1-25.0	4	4.6	22.0
Interorbital	3.1-4.6	21.6-32.0	4	3.9	27.7
Postorbital	1.8-2.0	50.0-57.0	4	1.8	54.3
Longest dorsal ray	2.5-3.6	27.8-40.0	4	3.1	32.6
Dorsal fin base	1.5-1.9	51.7-68.0	4	1.8	57.7
Longest anal ray	2.5-3.6	27.8-40.0	4	3.1	33.2
Anal fin base	1.4-2.0	50.0-69.3	4	1.8	57.1
Longest pectoral ray	2.0-2.9	35.0-50.1	4	2.5	41.6
Disc length	1.7-2.2	45.0-58.7	4	2.0	51.6

Aspasma minima (Döderlein)
(Fig. 6-8, Table 2).

Lepadogaster minimus Döderlein, 1887, p. 270.
Aspasma minima Jordan & Fowler 1902, p. 414; Jordan, Tanaka & Snyder 1913, p. 378; Okada and Matsubara 1938, p. 378; Okada 1938, p. 249; Matsubara, Tanaka, Mori and Aoyaki 1949, p. 321; Matsubara 1955, p. 1216; Okada and Uchida 1965, p. 483; Tomiyama, Abe and Tokioka, 1969, p. 86; Uchida 1966, p. 507.

DIAGNOSIS: A comparatively small species which retains a light yellow or whitish color in formalin. Dorsal fin 6-7. A distinct distance is between the caudal base and the end of the dorsal and anal bases.

DESCRIPTION: Based on four specimens, 18.5-25.6 mm in SL, which were collected from Ba-do-dz and Su-ao (as shown in Fig. 1). Dorsal fin 6-7; anal fin 6; pectoral fin 20; caudal fin rays 13-15; vertebral number 14–15+17–18=31–33.

Measurement (Number of times contained in SL and percent in parentheses): Head 2.8-3.2 (30.8-36.3); depth 6.4-7.5 (13.4-15.6); depth of head 7.5-8.4 (11.9-13.3); tip of snout to dorsal origin 1.3-1.5 (69.1-70.3), to anal origin 1.3-1.5 (69.0-77.0), to anterior base of ventral disc 3.1-4.1 (24.7-31.9), to pectoral origin 3.2-3.5 (28.8-31.3).

Measurement (Number of times contained in head length, and percent in parentheses): Snout length 3.3-4.9 (20.5-26.4); eye 4.0-5.5 (18.1-25.0); interorbital 3.1-4.6 (21.6-32.0); postorbital 1.8-2.0 (50.6-56.9); width of head 1.5-1.8 (56.9-68.0); disc length 1.7-2.2 (45.0-58.7); longest dorsal ray 2.5-3.6 (27.8-40.0); longest anal ray 2.5-3.6 (27.8-40.0); dorsal base 1.5-1.9 (51.7-68.0); anal base 1.4-2.0 (50.0-69.3); longest pectoral ray 2.0-2.9 (35.0-50.7).

Body is slender and only slightly depressed anteriorly and gradually compressed posteriorly from the posterior end of the ventral disc. The mouth is small, subterminal. The upper jaw is a little prominent, with the maxillae ending before the anterior margin of the eye. Two rows of incisors are on the upper jaw, the inner row consisting of only a few very small teeth at the front of the jaw, while the outer one large and well developed. A single row of incisors is on the lower jaw. The snout is round, and longer than the diameter of the eye. There are two nostrils, both with short tubes. The anterior one is before the medial anterior margin of the eye, while the posterior one is just infront of the upper anterior margin of the eye. The interorbital space is wide, slightly convex larger than the eye. The dorsal fin origin is behind the level of the anus. The anal fin origin is far behind the anus or with a distance about equal depth, slightly behind at the level of dorsal origin. Tips of depressed last dorsal and anal fin rays end far before the caudal base. The pectoral fins are round and connected with the posterior margin of the anterior disc by a membrane. The pelvic fins are incorporated into a prominent adhesive double type disc with papillae distributed over most of its surface as shown in Fig. 8. The caudal fin is round. The gill membranes are attached to the isthmus, with the upper attachment of the gill membranes opposite to 6-7 rays. The color in formalin is light yellow or whitish.

Lepadichthys frenatus Waite
(Fig. 9-11, Table 3).

Lepadichthys frenatus Waite, 1904, p. 180; McCulloch, 1923, p. 360; Chen, 1969; p. 193; Uchida, 1966, p. 507; Tomiyama, Abe and Tokioka, 1969, p. 85.
Aspasma misakia Tanaka, 1908, p. 22; Jordan, Tanaka and snyder, 1913, p. 378; Okada, 1938, p. 249; Matsubara, Tanada, Mori and Aoyaki, 1949, p. 320; Matsubara

1955, p. 1216.

DIAGNOSIS: A comparatively large species which retains light yellow or whitish color in formalin. Dorsal 17-18. Dorsal and anal fin united with caudal fin.

DESCRIPTION: Based on 34 specimens, 40.7-70.4 mm in SL, which were collected from Northern and North-eastern parts of Taiwan (as shown in Fig. 1). Dorsal fin 17-18; anal fin 14; pectoral fin 27-28; caudal fin 15-16; vertebral number 17+17−18=34−35.

Measurements (Number of times contained in SL and percent in parentheses): Head 2.6-3.4 (29.8-38.6); depth 5.0-6.8 (14.6-20.0), depth of head 6.6-8.6

TABLE 3
Counts and Measurements of *Lepadichthys frenatus* Waite

Count or Measurement	Range		Number of Indiv.	Mean	
	Proportion	Percent		Proportion	Percent
Total length (mm)	47.1-81.4		34		
Standard length (mm)	40.7-70.4		34		
Dorsal fin	17-18		34	17.2	
Anal fin	14		34	14	
Poctoral fin	27-28		34	27.4	
Pelvic fin	4		34	4	
Vertebral number	17+17−18=34−35		34		
In Standard length or Percent of Standard length:					
Head length	2.6-3.4	29.8-38.6	34	2.9	34.2
Body depth	5.0-6.8	14.6-20.0	34	6.0	16.5
Height of head	6.6-8.6	10.4-15.1	34	7.1	14.0
Dist. from tip of snout to:					
Dorsal origin	1.4-1.8	55.7-69.6	34	1.6	61.3
Anal origin	1.4-1.6	62.9-74.3	34	1.5	65.2
Disc origin	2.9-3.6	27.4-34.7	34	3.3	30.4
Pectoral origin	2.8-3.4	29.8-35.7	34	3.1	32.2
In Head length or percent of Head length:					
Snout length	3.3-5.6	18.0-30.3	34	3.5	24.4
Eye diameter	4.1-5.8	17.3-24.3	34	5.0	20.1
Interorbital	3.5-5.6	17.7-28.7	34	4.5	21.9
Postorbital	1.7-2.0	49.7-58.2	34	1.8	50.6
Longest dorsal ray	1.6-3.8	76.0-62.5	34	2.5	43.1
Dorsal fin base	1.5-2.8	36.3-65.3	34	2.4	42.2
Longest anal ray	1.8-3.6	28.1-56.7	34	2.6	39.8
Anal fin base	2.4-3.3	30.8-41.0	34	2.8	35.4
Longest pectoral ray	2.1-2.9	34.4-47.4	34	2.4	39.4
Disc length	1.4-1.8	55.1-70.0	34	1.6	60.8

(10.4-15.1); tip of snout to dorsal origin 1.4-1.8 (55.7-69.6), to anal origin 1.5-1.6 (62.9-74.0), to anterior base of ventral disc 2.9-3.6 (27.4-34.7), to pectoral origin 2.8-3.4 (29.8-35.7).

Measurements (Number of times contained in head length and percent in parentheses): Snout length 3.3-5.6 (18.0-30.3); eye 4.1-5.8 (17.3-24.3); interorbital 3.5-5.6 (17.7-28.7); postorbital 1.7-2.0 (49.7-58.2); width of head 1.4-2.6 (38.8-73.6); disc length 1.4-1.8 (55.1-70.0); longest dorsal ray 1.6-3.8 (62.5-76.0); longest anal ray 1.8-3.6 (28.1-56.7); longest pectoral ray 2.1-2.9 (34.4-47.4); dorsal base 1.5-2.8 (36.3-65.3); anal base 2.4-3.3 (30.8-41.0).

The body is slender and gradually compressed posteriorly at the level of dorsal origin. The head is moderately depressed and sharply narrrow from the middle of the eye anteriorly. The snout is medium, but longer than the eye, with the tip round from dorsal view and flattened from lateral view. Two nostrils are with very short tubes. The anterior one has a minute dermal flap extending from its posterior margin, while the posteroir one is located just before the anterior edge of the eye. The mouth is terminal, small, and slightly oblique. The maxillae end before the anterior margin of the eye. The length of the lower jaw is equal to that of the upper jaw. The teeth are conical, and recurved in a single row on both jaws, but none is present at the very tip of the upper jaw, since the premaxillaries fail to meet at this point where they are united by cartilage. Interorbital space is wide, flat or slightly concave, and about 1½ diameter of the eye. The gill membranes are confluent with the isthmus. The upper attachment of the gill membranes are opposite 5-6 pectoral rays. The dorsal fin originates above the anus. The anal fin originates about a distance of one diameter of eye behind the anus. The dorsal and anal fins are confluent with the caudal fin or united with 1/3-½ base of the caudal fin. The pectoral fins are round, and connected with the posterior margin of the anterior disc by a membrane. The pelvic fins are incorporated into a prominent adhesive single type disc with papillae distributed over most of its outer surface as shown in Fig. 11. Four rays of each ventral fin form the posterior edge of the anterior disc with the last ray having a membrane connected to the lower margin of the pectoral fin. The caudal fin is round.

The color in formalin is light yellow or whitish. The color of the fresh specimens is usually brown with thick mucous coat.

ZOOGEOGRAPHY

Most of the approximately one hundred species of the clingfishes occur in the tropical and temperate waters of the world. All but six of these species belong to four different subfamilies, Trachelochisminae, Diplocrepinae, Diademichthyinae and Aspasminae (2) in Indo-Pacific area excluding New Guinea, New Zealand and Australia.

Aspasma minima, *Aspasmichthys ciconae* belong to the subfamily Aspasminae, and *Conidens laticephalus* belongs to the subfamily Trachelochisminae. They are found only in the Northern Pacific Ocean from Taiwan Northward. The other species of the subfamily Trachelochisminae, however, are restricted to the waters of New Guiena, New Zealand and Australia. *Pherallodus indicus* and *Diademichthys lineatus* are confined in the waters from Philippine to Australia, but recently it was collected from Misaki (12). *Lepadichthys frenatus* is widely distributed from Japan to Australia. In Taiwan, there are only three species recognized and confined to the Northeastern coastal waters.

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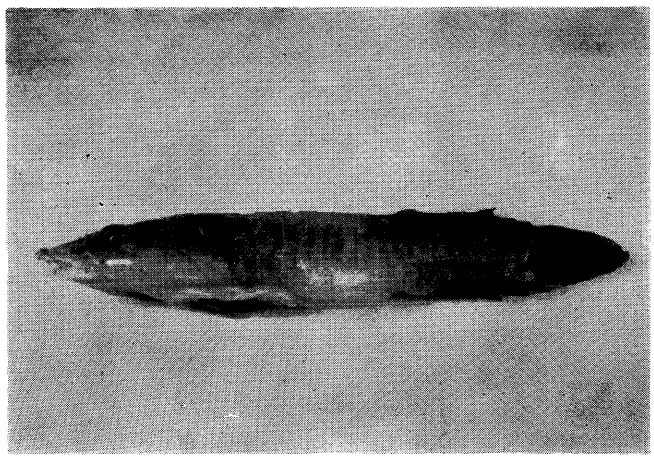

Fig. 3. Lateral view of *Conidens laticephalus* (TANAKA). (41.5mm in Total length, 34.6 mm in SL.)

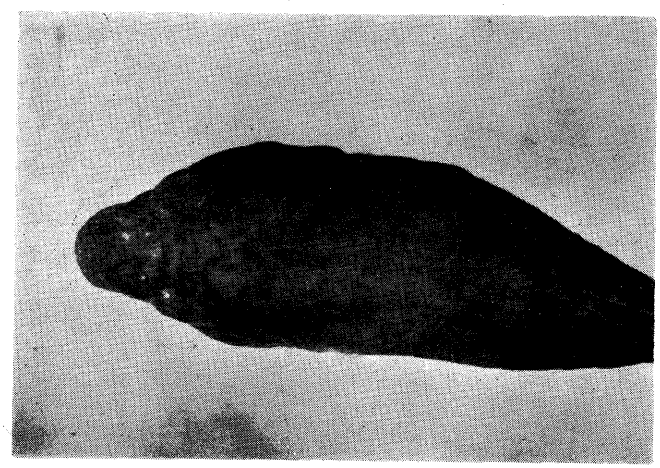

Fig. 4. Dorsal view of *Conidens laticephalus* (TANAKA). (Same specimen as shown in Fig. 3).

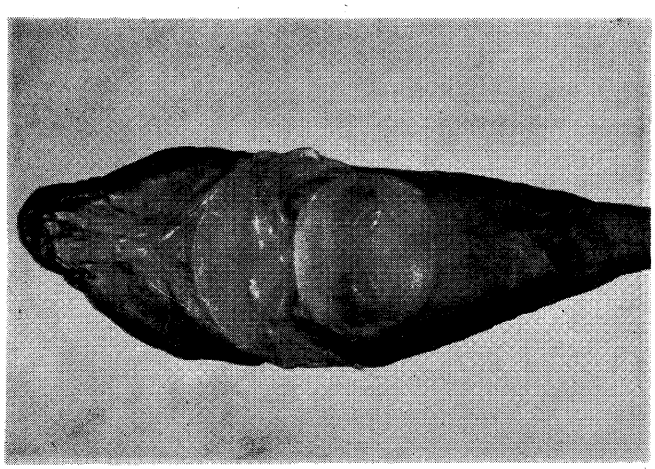

Fig. 5. Ventral view of *Conidens laticephalus* (TANAKA). (Same specimen as shown in Fig. 3).

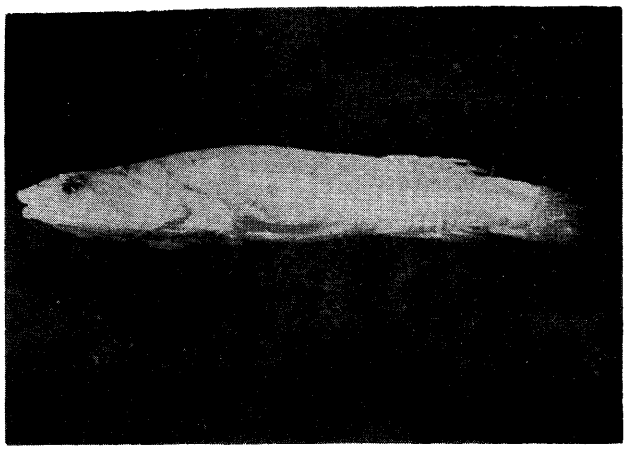

Fig. 6. Lateral view of *Aspasma minima* (Döderlein) (28.8 mm in Total length, 25.6 mm in SL.)

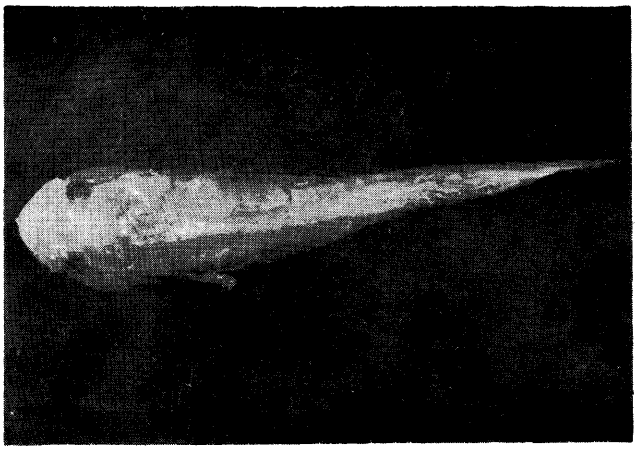

Fig. 7. Dorsal view of *Aspasma minima* (Döderlein). (Same specimen as shown in Fig. 6.)

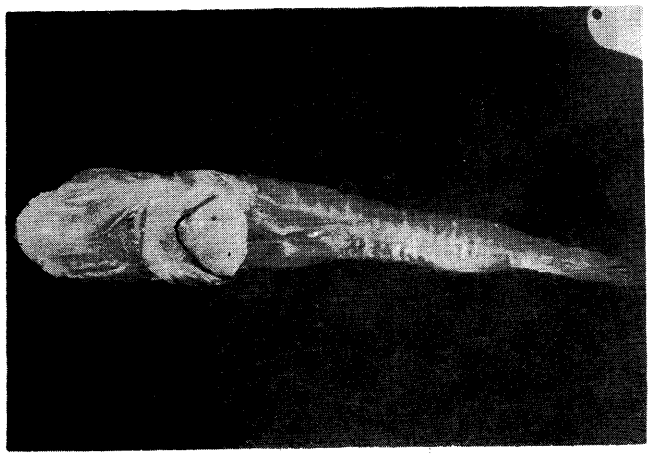

Fig. 8. Ventral view of *Aspasma minima* (Döderlein). (Same specimen as shomn in Fig. 6.)

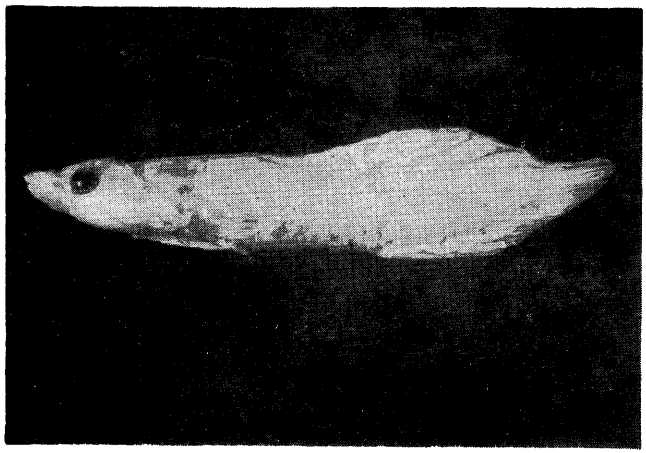

Fig. 9. Lateral view of *Lepadichthys frenatus* Waite. (75.2 mm in Total length, 67.3 mm in SL.)

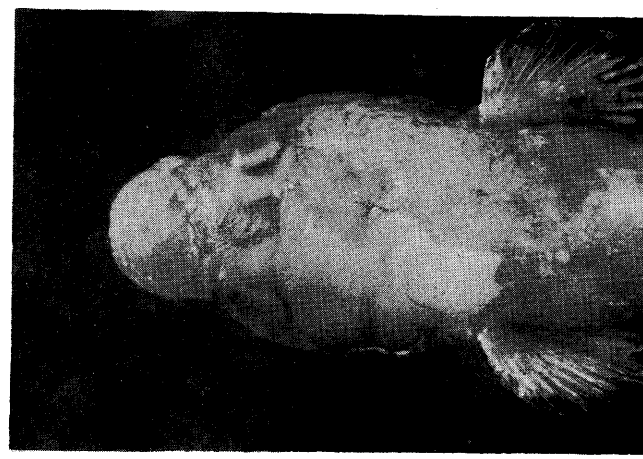

Fig. 10. Dorsal view of *Lepadichthys frenatus* Waite. (Same size as shown in Fig. 9.)

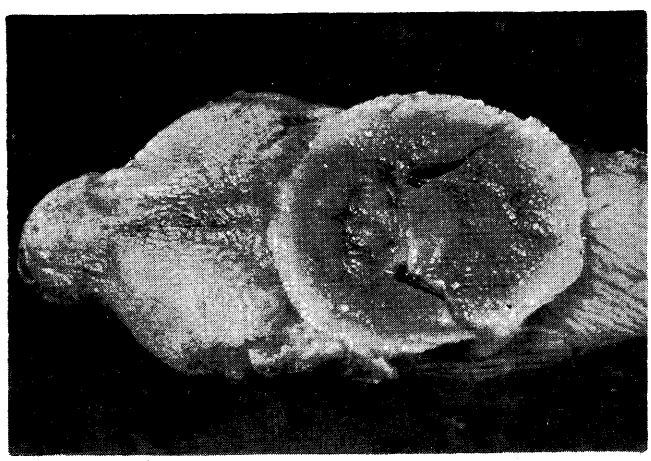

Fig. 11. Ventral view of *Lepadichthys frenatus* Waite. (Same size as shown in Fig. 9).