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Fishes of *Neoclinus* from Okinawa with Notes on the Traits of Their Habitats

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Abstract All the fish specimens of *Neoclinus bryope* species complex collected from Okinawa Island including the 2 specimens already reported as *N. bryope* are referable to *N. okazakii. Neoclinus nudus,* hitherto known only from Taiwan, is newly recorded from Okinawa Island. These two species are redescribed on the basis of the specimens from Okinawa Island. The specimens from Okinawa are compared with those from Shirahama in the case of *N. okazakii* and with specimens from Taiwan as well as *N. lacunicola* and *N. toshimaensis* specimens from Shirahama in the case of *N. nudus*. The habitats of *N. okazakii* and *N. nudus* are clearly separated in the waters of Heshikiya, Okinawa Island and the habitat of either species is rather particular in that it is exceptionally unoccupied by blenniids which are flourishing in the coastal waters of the Okinawa Islands.

Among fishes of *Neoclinus*, only two specimens of "*Neoclinus bryope* (National Museum of Natural History, Smithsonian Institution, Washington, D.C., USNM 132808 and 195823)" have hitherto been reported from Okinawa (Stephens, 1961). Fukao (1987) noted that these two specimens may belong to *N. okazakii*, *N. chihiroe*, or to a fourth form of *N. bryope* species complex (Fukao and Okazaki, 1987). The present study revealed that they were referable to *N. okazakii*. Moreover, four specimens of *Neoclinus nudus* were discovered in the collection of the Department of Marine Sciences, University of the Ryukyus (URM-P 10186 and 20341). During the period from April 28 to May 2, 1985, the author also collected 15 specimens of *N. nudus* and 36 specimens of *N. okazakii* from the waters of Heshikiya, Katsuren Peninsula, Okinawa Island, Japan (26°18′N, and 127°56′E). These two species from Okinawa are described based on the specimens noted above. *N. nudus* are recorded for the first time from Japan. In the case of *N. okazakii*, the data in Fukao (1987) derived from 47 specimens from Shirahama were used for comparison. In the case of *N. nudus*, 2 of the 10 paratypes of *N. nudus* (USNM 205218) from Taiwan, 133 specimens of *N. lacunicola* including the holotype (Faculty of Agriculture, Kyoto University, FAKU 49521) from Shirahama, and 161 specimens of *N. toshimaensis* including the holotype (FAKU 48522) from Shirahama were examined for comparison. The methods of counts and measurements followed Fukao (1987). Dentition, gill rakers, and caudal skeleton were examined for 5 cleared and stained specimens of each of *N. okazakii* and *N. nudus* from Okinawa. Proportional measurements are expressed in percent of standard length. Regression line formulae of each proportion to standard length were calculated. A special reference is also made on the traits of their habitats from the observation in the waters of Heshikiya.

Neoclinus okazakii Fukao, 1987
(Japanese name: Araiso-koke-ginpo)
(Fig. 1A)

Neoclinus bryope: Stephens, 1961: 484; Fukao, 1980: 193 (in part).
Neoclinus okazakii Fukao, 1987: 294.

Specimens examined. USNM 132808, female, 36.6 mm in SL, Hiza, Onna, Okinawa Island, Sept. 8, 1945, collected by J. R. Simon; USNM 195823, male, 37.0 mm, East coast of Kimmu Wan Bay (=Kin Bay), Okinawa Island, Sept. 1, 1945, collected by J. R. Simon; FAKU 112023, female, 52.2 mm, May 2, 1985; FAKU 112024, male, 52.1 mm, May 2, 1985; FAKU 112025, female, 48.7 mm, May 2, 1985; FAKU 112026, male, 46.2 mm, May 2, 1985; FAKU 112027, female, 45.5 mm, May 2, 1985; FAKU 112028, male, 33.2 mm, May 2, 1985; FAKU 112029, female, 49.3 mm, May 2, 1985; FAKU 113025, 25 males, 34.0-58.0 mm, 4 females, 42.6-49.1 mm, Apr. 28 to May 1, 1985. Specimens of FAKU were all collected by R. Fukao from Heshikiya, Katsuren Peninsula, Okinawa Island.

Description. Dorsal fin, XXIII-XXVI, 15-18; anal fin, II, 27-30; caudal fin, 5-6+13+4-6, a minimal hypural present, epural 1 or 2; pectoral fin, 12-13; pelvic fin, I, 3; vertebrae, 12+33-35=45-47; gill rakers, 5-10+11-17=18-27; lateral line pores 35-49; cephalic sensory pores: total, 60-73; occipital

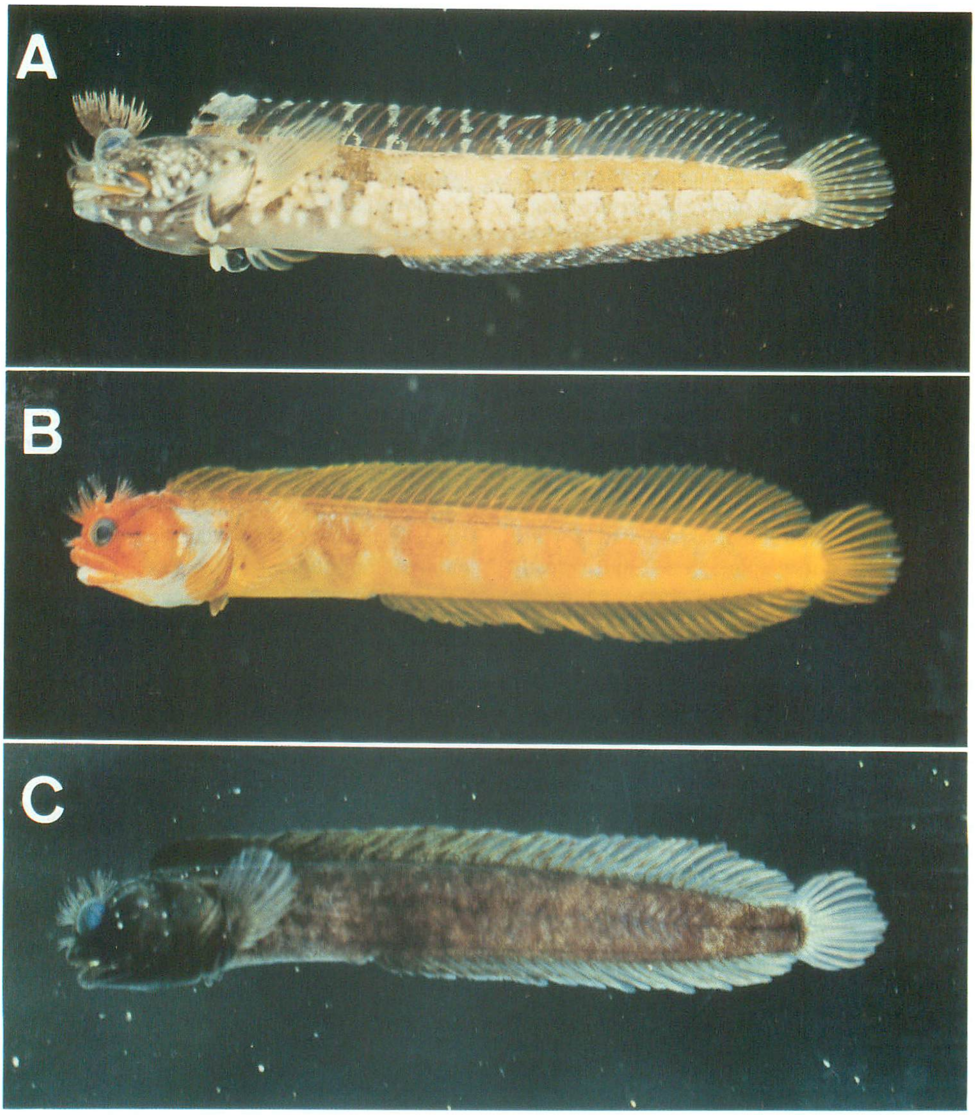

Fig. 1. *Neoclinus* from Heshikiya, Okinawa Island. A, *N. okazakii*, barred pattern (FAKU 112023); B, *N. nudus*, barred pattern, reddish phase (FAKU 112030); C, *N. nudus*, plain pattern, blackish phase (FAKU 112032).

series, 7–10; preopercular series, 11–15; mandibular series, 4–6; posttemporal series, 3–4; temporal series, 3–7; nasal series, 3; infraorbital series, 12–18; supraorbital series, 6–11; frontal 1 series, 1–5; frontal 2 series, 1–5. Mean values of meristic counts are shown in Tables 1 and 2.

Proportional measurements are presented in Table 3. The proportional changes with growth are observed in the following 5 morphometric characters. Predorsal length, head length, orbital length, longest pectoral ray length, and longest pelvic ray length show negative allometry. Besides these, significant difference between sexes was observed in the following 2 morphometric characters. While upper jaw length of male shows rather positive allometry, that of female shows negative allometry (in specimens over 45 mm in SL, males larger than females). While longest dorsal spine length of male show positive allometry, that of female is regarded as isometry (in specimens over 45 mm, males mostly larger than females).

Nasal cirri 2 to 6 on posterior rim of each anterior nostril. Orbital cirri 3 arranged in single row, much branched; usually first cirrus longest and most branched.

Upper jaw with 22 to 26 teeth on each side in outer row; anterior 6 to 7 larger incisorlike teeth; posterolateral 15 to 20 smaller conical teeth; a patch of minute villiform teeth posterior and medial to anterior outer row. Lower jaw with 21 to 25 teeth on each side in outer row; anterior 6 to 8 larger incisorlike teeth, followed 2 to 3 moderately developed canines; 13 to 16 posterolateral smaller conical teeth; a patch of small villiform teeth posterior and medial to anterior outer row. Vomer with 4 to 6 conical teeth. Palatine with 9 to 10 uniserial conical teeth.

Raised, distinct lateral line on body running posteriorly from upper margin of opercle to a point below 10th to 12th dorsal spine; first 0 to 2 (mostly 1) single median pore, followed 15 to 23 paired pores, sometimes the row of paired pores interrupted by 1 to 5 unpaired pores, lasting 1 to 2 single median pore (mostly 1).

Head and all fins naked. Scales on body nonimbricated and somewhat difficult to observe; areas above lateral line, below the line from anus to upper edge of opercle, and areas covering inclinater muscle of dorsal and anal fins almost scaleless.

Dorsal fin spine soft and flexible except for last 1 (12 inds.), 2 (22 inds.), or 3 (1 ind.) ones which are stiff and noticeably shorter; last dorsal spine not or reaching margin of fin membrane.

Color in life: Color pattern varies from almost plain to strongly barred. Body light tan to dusky tan, sometimes slightly tinged with orange. In barred pattern specimens, 8 to 10 darker vertical irregular or diamond like bars and sometimes 2 to 5 less distinct intermediate ones; rarely the upper middle broadest part of bar coalesced with each other to make a longitudinal stripe. Seven to 8 saddlelike bars across the dorsal base. Opercular membrane margined with black and the upper edge distinctly black.

Table 1. Mean values with standard deviation of meristic characters in *Neoclinus okazakii.* Numerals in parentheses are the number of the specimens examined. Significantly different ($p<0.01$) mean values between the two local populations are expressed by bold-faced letters.

	Dorsal spines	Dorsal soft rays	Total dorsal elements	Anal soft rays
USNM 132808	24	16	40	28
USNM 195823	25	16	41	29
Okinawa	24.3±0.6 (37)	16.4±0.6 (37)	40.7±0.6 (37)	28.7±0.7 (37)
Shirahama	24.5±0.5 (47)	16.5±0.7 (47)	41.0±0.6 (47)	28.8±0.7 (47)
	Total pectoral rays	**Vertebrae**	**Nasal cirri**	**Lateral line pores**
USNM 132808	26	46	6	46
USNM 195823	26	47	9	43
Okinawa	26.0±0.2 (36)	46.5±0.6 (38)	**7.3**±1.5 (31)	**44.6**±2.7 (37)
Shirahama	25.9±0.6 (47)	46.5±0.6 (47)	**9.8**±1.8 (47)	**47.2**±2.3 (45)

Table 2. Mean values with standard deviation of cephalic sensory pore counts in *Neoclinus okazakii.* OC, occipital series; PO, preopercular series; M, mandibular series; PT, posttemporal series; T, temporal series; N, nasal series; IO, infraorbital series; SO, supraorbital series; F 1, frontal 1 series; F 2, frontal 2 series.

	n	OC	PO	M	PT	T
USNM 132808	1	7	14	5	4	5
USNM 195823	1	8	13	5	4	4
Okinawa	38	8.1±0.7	13.3±0.9	5.0±0.4	3.8±0.4	4.7±0.9
Shirahama	48	7.6±0.7	13.7±1.2	5.6±0.5	4.0±0.5	4.3±1.0
	N	**IO**	**SO**	**F1**	**F2**	**Total**
USNM 132808	3	13	11	3	3	68
USNM 195823	3	13	6	4	3	63
Okinawa	3.0	13.7±1.2	8.2±1.1	3.2±0.8	3.1±1.0	66.1±2.9
Shirahama	3.0	13.9±1.0	8.1±1.1	3.4±1.1	2.5±0.9	66.1±3.7

One black ocellus with or without paler margin on anterior dorsal fin; margined ocellus observed in larger specimens of both sexes. Anal fin with or without submarginal dusky band; complete band mostly observed in larger male; some smaller specimens with other markings (several oblique dot lines, random dot, or no marking).

Remarks. Three members of *Neoclinus bryope* complex closely resemble one another superficially, but are separable primarily by the combination of two meristic characters, the number of vertebrae and the total number of cephalic sensory pores, i. e., *N. bryope* has 47 to 49 vertebrae and 49 to 57 pores, *N. chihiroe* has 44 to 46 vertebrae and 49 to 55 pores, and *N okazakii* has 45 to 47 vertebrae and 58 to 78 pores (Fukao, 1987). Present study revealed that the two specimens (USNM 132808 and 195823) reported as *N. bryope* from Okinawa by Stephens (1961) were referable to *N. okazakii*, having 46 and 47 vertebrae, respectively and 68 and 63 total cephalic sensory pores, respectively. All the other 36 specimens of *N. bryope* complex from Okinawa examined in this study were also referable to *N. okazakii*, having 45 to 47 vertebrae and 60 to 73 pores. This is supported by electrophoretic data (Fukao and Okazaki, in press). It is well known that meristic characters are often variable among populations from different localities. In the case of vertebrae, especially, the number is generally influenced by the ambient water temperature during the development (Garside, 1966). Although breeding of this species could not be observed in the present study, reproduction is considered to occur during the cold months like that of "*N. bryope*" (Kimura et al., 1984; Shiogaki and Dotsu, 1972; Usuki, 1979) in the temperate waters of Shirahama judging from the following facts.

Two presumably newly settled young (under 30 mm in SL, cf. Shiogaki and Dotsu, 1972) were collected in May (out of 6 specimens collected) and another in middle June (out of 16 specimens collected), but none in late June to early July in spite of the most intensive collection (36 specimens collected; minimum 33.9 mm in SL). On the other hand, a young of 35.2 mm in SL was collected in middle April (out of 2 specimens collected). These condi-

Table 3. Ranges and mean values with standard deviation of proportions, and regression lines of proportions to standard length in *Neoclinus okazakii* from Okinawa.

	n	Range	Mean±SD	Regression line	r	p
Standard length (in mm)	38	33.2– 58.0	46.8±5.7			
Total length	31	111.4–115.8	113.9±0.9	Y=−0.041X+115.9	−0.236	0.201
Body depth	37	14.3– 17.1	15.6±0.7	Y=−0.015X+ 16.3	−0.121	0.475
Body depth at anal origin	37	12.6– 15.4	14.2±0.7	Y=−0.026X+ 15.4	−0.221	0.189
Caudal peduncle depth	37	6.2– 7.7	7.0±0.4	Y= 0.008X+ 6.6	0.125	0.459
Caudal peduncle length	37	4.8– 6.4	5.7±0.4	Y= 0.003X+ 5.5	0.046	0.788
Predorsal length	38	16.6– 21.2	18.8±0.9	Y=−0.117X+ 24.3	−0.753	0.000
Preanal length	38	42.6– 48.3	45.3±1.4	Y= 0.007X+ 44.9	0.032	0.847
Anal origin to pelvic insertion	♂27	22.6– 28.8	25.6±1.4	Y= 0.091X+ 21.3	0.361	0.064
	♀ 9	23.0– 27.5	25.3±1.4	Y= 0.023X+ 24.2	0.075	0.847
Head length	38	23.4– 27.0	25.1±0.9	Y=−0.094X+ 29.6	−0.588	0.000
Head width	9	13.8– 18.7	16.8±1.9	Y= 0.072X+ 13.6	0.267	0.487
Postorbital length of head	38	13.8– 16.7	15.2±0.6	Y= 0.013X+ 14.5	0.120	0.471
Orbital length	38	5.6– 7.6	6.4±0.5	Y=−0.064X+ 9.4	−0.811	0.000
Upper jaw length	♂29	12.7– 15.2	14.0±0.5	Y= 0.026X+ 12.7	0.295	0.120
	♀ 9	12.5– 14.5	13.2±0.6	Y=−0.124X+ 19.0	−0.924	0.000
Dorsal fin base length	37	74.7– 83.1	79.6±1.8	Y= 0.096X+ 75.0	0.293	0.078
Anal fin base length	♂28	48.8– 55.7	52.5±1.5	Y=−0.030X+ 54.0	−0.119	0.547
	♀ 8	51.1– 55.5	53.2±1.3	Y=−0.186X+ 61.9	−0.681	0.062
Longest dorsal spine length	♂28	8.9– 13.6	11.2±1.1	Y= 0.083X+ 7.3	0.413	0.029
	♀ 7	8.0– 10.5	9.3±0.9	Y=−0.061X+ 12.2	−0.331	0.468
Longest dorsal soft ray length	33	9.6– 12.4	10.7±0.7	Y=−0.002X+ 10.8	−0.023	0.899
First anal spine length	38	3.9– 5.3	4.4±0.3	Y=−0.011X+ 4.9	−0.206	0.215
First anal soft ray length	38	6.1– 8.9	7.0±0.6	Y=−0.012X+ 7.6	−0.118	0.481
Longest pectoral ray length	35	12.4– 16.7	14.2±0.9	Y=−0.105X+ 19.1	−0.658	0.000
Longest pelvic ray length	33	10.4– 14.2	12.1±1.1	Y=−0.082X+ 16.0	−0.439	0.010

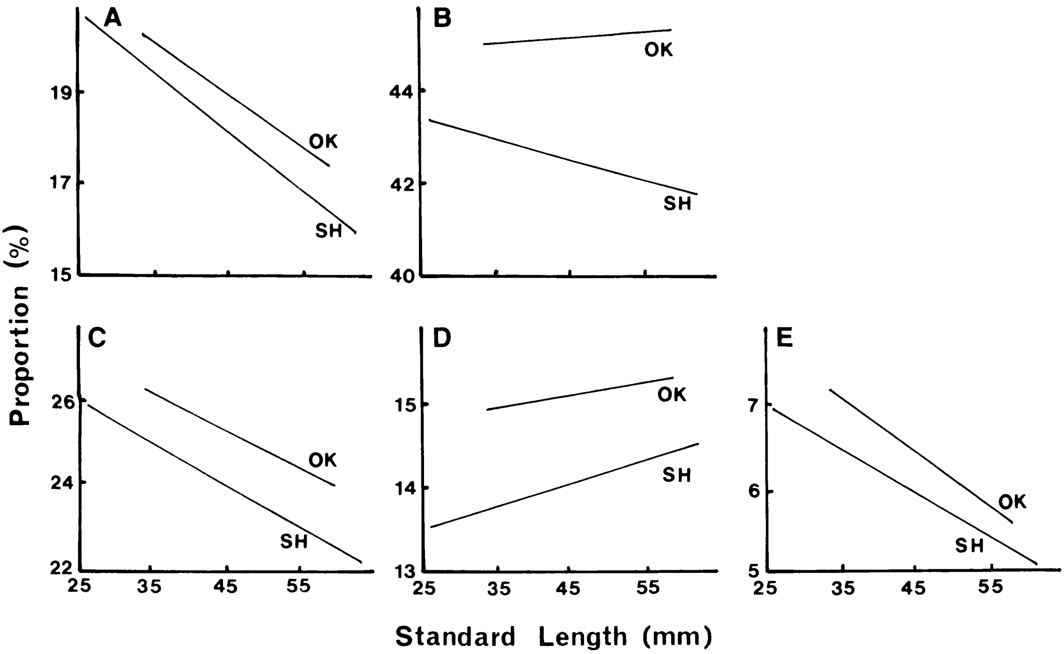

Fig. 2. Comparison of proportions of some morphometric characters in two local populations of *Neoclinus okazakii*. A, predorsal length; B, preanal length; C, head length; D, postorbital length of head; E, orbital length. OK, Okinawa; SH, Shirahama.

tions were nearly identical with the occurrence of young of *N. bryope*. In the present study, only 2 males were collected during the cold months (61.9 mm in SL, Dec. 4, 1976; 49.2 mm in SL, Feb. 3, 1977). These 2 males have somewhat distended blade-like tips of anal soft rays which are not observed in males collected during the warm months. The similar modification in anal fin is sometimes observed characteristically in nuptial males of blenniids (Smith, 1974; Smith-Vaniz, 1976; Springer and Gomon, 1975; Zander, 1975). In adult specimens collected during warm months (12 males and 10 females examined), testes were thread-like and no ripe egg was observed in the ovaries which were small and undifferentiated.

In Okinawa Island, water temperature falls down to about 19°C in mid-winter (Nakamura, 1983, 1984). In Shirahama, it falls down to about 14°C in mid-winter and is under 19°C during the period from middle November to middle April (data from Seto Marine Biological Laboratory). Thus, the ambient water temperature during the development is expected to be considerably different between these two localities. Nevertheless, the above noted two meristic characters fall within the same diagnostic range in both the local populations. These two characters are presumably fixed genetically in the range of the species and are effective diagnostic ones. On the other hand, significant differences between these two local populations were noticed in the total free tips of nasal cirri ($t=6.82$, $p<0.01$) and in lateral line pore counts ($t=5.15$, $p<0.01$) (Table 1). Significant differences were also observed in proportions of some morphometric characters. Proportions of orbital length, postorbital length of head, head length, predorsal length, and of preanal length in Okinawan specimens were slightly larger than those in Shirahama specimens (Fig. 2). In general, northern, slowly growing races of a species usually have smaller head, eyes, maxillaries, and fins than do their counterparts (Barlow, 1961). The above noted differences suggest that the fish from these two localities may be treated as the different geographical races.

Neoclinus nudus Stephens et Springer, 1971
(New Japanese name: Hadaka-koke-ginpo)
(Fig. 1B, C)

Neoclinus nudus Stephens and Springer, 1971: 65.

Specimens examined. URM-P 10186, male, 36.5 mm in SL, female, 41.2 mm, Katsuren Peninsula, Okinawa Island, collected by M. Oshiro; URM-P 20341, 2 females, 34.0–35.9 mm, Sept. 9, 1979, Heshikiya, Katsuren Peninsula, Okinawa Island, collected by M. Oshiro; FAKU 112030, male, 51.9 mm, May 2, 1985; FAKU 112031, female, 39.1 mm, May 2, 1985; FAKU 112032, male, 44.0 mm, May 2, 1985; FAKU 113026, 9 males, 39.8–46.1 mm, 2 females, 38.8–45.9 mm, 1 unknown sex, 38.8 mm, Apr. 30 to May 1, 1985. Specimens of FAKU were all collected by R. Fukao from Heshikiya, Katsuren Peninsula, Okinawa Island.

Description. Dorsal fin, XXIV-XXVI, 16–18; anal fin, II, 28–30; caudal fin, 6–7+13+5–6, a minimal hypural present, epural 1 or 2; pectoral fin, 12–14; pelvic fin, I, 3; vertebrae, 13+34–36=47–49; gill rakers, 6–7+11–13=17–19; lateral line pores, 26–38; cephalic sensory pores: total, 45–51; occipital series, 5–6; preopercular series, 11–13; mandibular series, 5–6; posttemporal series, 3; temporal series, 2–3; nasal series, 2–3; infraorbital series, 12–13; supraorbital series, 3–6; frontal 1 series, 1; frontal 2 series, 0–1. Mean values of meristic counts are shown in Tables 4 and 5.

Proportional measurements are presented in Table 6. The proportional changes with growth are observed in the following 6 morphometric characters. Total length (i.e., caudal fin length), predorsal length, preanal length, head length, longest pectoral ray length and longest pelvic ray length show negative allometry.

Nasal cirri slender, sometimes bifurcated; 3 to 8 free tips on posterior rim of each anterior nostril. Orbital cirri 7 arranged in 2 rows; 4 cirri on outer row, 3 cirri on inner row; cirri on outer row with long slender branches; anterior 2 cirri on inner row with or without short blunt branches; last cirrus on inner row with long slender branches and with or without short blunt ones (Fig. 3).

Upper jaw with 17 to 21 teeth on each side in outer row; anterior 6 to 7 recurved larger incisorlike teeth; posterolateral 11 to 14 smaller conical teeth; a patch of minute villiform teeth posterior and medial to anterior outer row. Lower jaw with 15 to 21 teeth on each side in outer row; anterior 5 to 8 recurved larger

Table 4. Mean values with standard deviatiön of meristic characters in *Neoclinus nudus*, *N. lacunicola*, and *N. toshimaensis*. OK, Okinawa; TA, Taiwan. Numerals in parentheses are the number of specimens examined. Significantly different ($p<0.01$) mean values between the two local populations of *N. nudus* are expressed by bold-faced letters. *After Stephens and Springer (1971).

	Dorsal spines	Dorsal soft rays	Total dorsal elements	Anal soft rays
N. nudus (OK)	24.6±0.6 (19)	16.9±0.7 (19)	41.5±0.7 (19)	28.4±0.6 (19)
N. nudus (TA)	25.4±0.5 (11)*	16.7±0.5 (11)*	42.1±0.7 (11)*	28.8±0.4 (11)*
N. lacunicola	23.1±0.7 (133)	17.8±0.8 (133)	40.8±0.7 (133)	27.7±0.6 (132)
N. toshimaensis	24.7±0.8 (160)	18.9±0.9 (160)	43.6±0.7 (160)	29.4±0.6 (161)
	Total pectoral rays	**Vertebrae**	**Nasal cirri**	**Lateral line pores**
N. nudus (OK)	**26.4**±0.6 (19)	47.5±0.7 (19)	**9.8**±0.9 (15)	**31.3**±3.4 (19)
N. nudus (TA)	**28.1**±0.9 (11)*	48.0 (2)	**18.0**±4.2 (2)	**22.5**±2.1 (2)
N. lacunicola	26.1±0.5 (132)	46.8±0.7 (133)	6.4±1.3 (133)	18.7±3.8 (126)
N. toshimaensis	28.0±0.5 (159)	50.1±0.6 (157)	10.6±4.0 (153)	22.2±3.8 (152)

Table 5. Mean values with standard deviation of cephalic sensory pore counts in *Neoclinus nudus*, *N. lacunicola*, and *N. toshimaensis*. OK, Okinawa; TA, Taiwan. Abbreviations are the same as in Table 2.

	n	OC	PO	M	PT	T
N. nudus (OK)	18	5.3±0.5	11.8±0.6	5.2±0.4	3.0	2.1±0.2
N. nudus (TA)	2	6.0±1.4	11.5±0.7	6.0	3.0	2.0
N. lacunicola	128	5.0±0.3	9.7±0.7	5.1±0.3	3.0±0.2	2.1±0.3
N. toshimaensis	155	4.9±0.5	9.2±1.0	5.1±0.2	2.9±0.3	2.0±0.2
	N	**IO**	**SO**	**F1**	**F2**	**Total**
N. nudus (OK)	2.8±0.4	12.7±0.5	3.7±0.8	1.0	0.2±0.4	47.6±1.6
N. nudus (TA)	3.0	13.0	3.0	1.0	0.0	48.5±0.7
N. lacunicola	3.0	11.5±0.7	4.8±0.6	1.0	0.9±0.3	46.0±1.5
N. toshimaensis	3.0	11.7±1.2	5.1±0.4	1.0±0.1	1.0±0.1	45.8±1.9

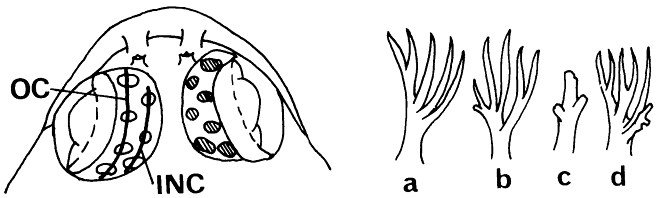

Fig. 3. Arrangement and shape of orbital cirri in *Neoclinus nudus*. INC, cirri in inner row; OC, cirri in outer row. a, anteriormost OC; b, posterior 3 OC; c, anterior 2 INC; d, posteriormost INC.

incisorlike teeth, followed 1 to 3 moderately developed canines; 7 to 12 posterolateral smaller conical teeth; a patch of small villiform teeth (less than those on upper jaw in number, slightly larger in size) posterior and medial to anterior outer row. Vomer with 5 to 7 conical teeth in an anterior crescentic row. Palatine with 7 to 12 uniserial conical teeth.

Raised distinct lateral line on body running posteriorly from upper margin of opercle to a point below 4th to 9th dorsal spine; first 0 to 1 (mostly 1) single median pore, followed 11 to 18 paired pores, sometimes the row of paired pores interrupted by 1 to 4 unpaired pores, lasting 1 to 2 single median pore (mostly 1).

Head and all fins naked. A row of scales on an extension line of lateral line from end of the lateral line to a point below 10th or 11th dorsal spine (one scale in each somite), where the row abruptly turns downward to midlengthwise axis of body, and then runs to caudal base (one or two scales on each somite).

Dorsal fin spines soft and flexible except for last 1 (16 inds.) or 2 (3 inds.) which are stiff and slightly shorter; a narrow membrane along anterior edge of 1st spine. Soft dorsal fin higher than spinous dorsal fin; last spine not or reaching margin of the fin membrane.

Color in life: Two color phases, reddish and blackish ones, exist. Both phases varying in pattern from plain to strongly barred. Reddish phase: Head bright red; opercle mottled with darker or not (in a specimen of three days after preserved in 10% formalin, opercle, opercular membrane and under side of head turn to white: Fig. 1B). In plain pattern

Table 6. Ranges and mean values with standard deviation of proportions, and regression lines of proportions to standard length in *Neoclinus nudus* from Okinawa.

	n	Range	Mean±SD	Regression line	r	p
Standard length (in mm)	18	34.0– 51.9	41.7±4.4			
Total length	13	112.0–117.1	113.6±1.3	Y=−0.150X+119.8	−0.558	0.047
Body depth	12	14.2– 16.2	15.1±0.7	Y=−0.032X+ 16.4	−0.225	0.482
Body depth at anal origin	18	11.5– 14.3	12.9±0.7	Y=−0.064X+ 15.6	−0.419	0.083
Caudal peduncle depth	18	5.7– 7.2	6.4±0.4	Y= 0.007X+ 6.1	0.078	0.757
Caudal peduncle length	18	5.0– 6.6	5.7±0.4	Y= 0.018X+ 4.9	0.187	0.456
Predorsal length	18	15.6– 18.3	16.9±0.9	Y=−0.163X+ 23.7	−0.839	0.000
Preanal length	18	41.2– 46.9	43.7±1.7	Y=−0.183X+ 51.4	−0.488	0.039
Anal origin to pelvic insertion	17	22.0– 27.8	25.2±1.6	Y=−0.111X+ 29.9	−0.306	0.232
Head length	18	20.5– 23.2	22.2±0.8	Y=−0.116X+ 27.1	−0.660	0.002
Head width	18	11.5– 16.4	14.0±1.5	Y= 0.014X+ 13.4	0.043	0.865
Postorbital length of head	18	13.0– 15.0	14.1±0.5	Y=−0.040X+ 15.8	−0.328	0.184
Orbital length	18	5.2– 6.5	5.8±0.4	Y=−0.022X+ 6.8	−0.266	0.285
Upper jaw length	18	10.5– 12.8	11.8±0.7	Y= 0.007X+ 11.5	0.041	0.870
Dorsal fin base length	18	77.3– 84.2	81.7±2.0	Y= 0.113X+ 77.0	0.246	0.324
Anal fin base length	18	49.5– 55.0	52.6±1.4	Y= 0.049X+ 50.6	0.156	0.536
Longest dorsal spine length	13	8.4– 11.0	9.4±0.9	Y=−0.029X+ 10.6	−0.161	0.599
Longest dorsal soft ray length	16	9.7– 11.9	10.8±0.6	Y=−0.027X+ 11.9	−0.197	0.464
First anal spine length	18	3.2– 5.5	4.2±0.6	Y=−0.042X+ 5.9	−0.319	0.195
First anal soft ray length	18	5.9– 7.9	6.7±0.6	Y=−0.021X+ 7.6	−0.166	0.509
Longest pectoral ray length	16	11.3– 14.4	12.6±0.8	Y=−0.123X+ 17.7	−0.685	0.003
Longest pelvic ray length	17	8.0– 11.8	9.7±0.9	Y=−0.098X+ 13.8	−0.491	0.045

specimens, body uniformly yellow to reddish orange. In barred pattern specimens, body with 10 yellow to reddish orange bands which are coalesced with each other ventrally; sometimes upper part of body band bordering a whitish blotch; 9 yellow to reddish orange saddlelike bars across the dorsal base; interspaces white tinged with or without yellow. Blackish phase: white spots on circumorbital region and posterior margin of opercle. In plain pattern specimens, body uniformly black (Fig. 1C). Banding pattern in barred pattern specimens is about the same as that in reddish phase specimens, but the bands are black and the interspaces are dusky white.

Remarks. Stephens and Springer (1971) noted that *Neoclinus nudus* differed from all the other species of *Neoclinus* in completely lacking scales. Specimens from Okinawa examined in this study have a row of scales along the mid-line of body. The scales, however, are not visible normally in the specimens from Okinawa as reported for fish from Taiwan by Stephens and Springer (1971). They are barely discernible only after cleared and stained (with pale blue by alcian blue in the combined staining of cartilaginous and ossified components). The fish from Taiwan could not be determined to have a row of scales along the mid-line of body. The other characters in the specimens from Okinawa fitted generally with those from Taiwan, though significant differences were observed in the number of total pectoral fin rays ($t=4.96$, $p<0.01$), total free tips of nasal cirri ($t=7.91$, $p<0.01$), and of lateral line pores ($t=3.50$, $p<0.01$) between them (Table 4).

Two color phases, reddish and blackish, were observed the living fish. These color phases did not change about a month in captivity. Seven fish with reddish phase included 3 males, 3 females and 1 sex unknown. Eight fish with blackish phase were all males. The origin of these two color phases has not been established by the present study.

Based on the Nei's genetic distance (D) values obtained by the electrophoretic analysis (Fukao and Okazaki, in press), the present species form a group with *N. lacunicola* and *N. toshimaensis*. Morphologically, these three species are easily distinguished from the three species of *N. bryope* complex in the number and the arrangement of orbital cirri (6 to 11 cirri arranged in two or three rows instead of 3 or 4 cirri in a single row). The number and the arrangement of the orbital cirri in *N. nudus* are the same as those in *N. lacunicola* (mostly 7 cirri arranged in 2 rows) and are different from those in *N. toshimaensis* (mostly 9 cirri arranged in 3 rows in middle part). In that the long slender branches of the cirri over eyes enclose the short blunt branches, the present species is rather closer to *N. toshimaensis* than to *N. lacunicola*. Thus, the present species shows an intermediate condition between *N. lacunicola* and *N. toshimaensis* in the orbital cirri. Intermediate condition is also observed in the number of vertebrae and of anal soft rays (Table 4). Interestingly, while specimens from Okinawa are close to *N. lacunicola*, specimens from Taiwan are close to *N. toshimaensis* in pectoral ray counts. *N. nudus* is also intermediate in the counts of total dorsal elements, another distinguishing character between *N. lacunicola* and *N. toshimaensis* (Table 4). In the ratio of dorsal soft ray counts to spine counts, however, *N. nudus* is distant from *N. lacunicola* and *N. toshimaensis* which are very close to each other (Table 7). Although the total counts are not so significantly different, cephalic sensory pore counts in preopercular, infraorbital, supraorbital and frontal 2 series of the present species are also significantly different from those of the other two species which are nearly identical with each other (Table 5). Moreover, the present species is clearly distinct from *N. lacunicola* and *N. toshimaensis* in the absence of a pair of nuchal cirri, the presence of a minimal hypural, the highly degenerated squamation, and in the body coloration. *N. lacunicola* and *N. toshimaensis* are nearly identical in the squamation and very similar to each other in the body coloration of reddish phase specimens (Fukao, 1980). Although *N. nudus* shows intermediate condition between *N. lacunicola* and *N. toshimaensis* in some characters as noted above, the similarity between the latter two species is seemingly superior to that between *N. nudus* and either of the latter two species in the morphology as a whole.

Table 7. The ratio of dorsal soft ray counts to dorsal spine counts (expressed as percent) in *Neoclinus nudus*, *N. lacunicola*, and *N. toshimaensis*. OK, Okinawa; TA, Taiwan. *After Stephens and Springer (1971).

	n	$\bar{x} \pm SD$	Range
N. nudus (OK)	19	68.8±3.7	61.5–75.0
N. nudus (TA)*	11	66.0±2.2	61.5–68.0
N. lacunicola	133	77.1±4.8	66.7–86.4
N. toshimaensis	160	76.9±4.9	59.3–87.5

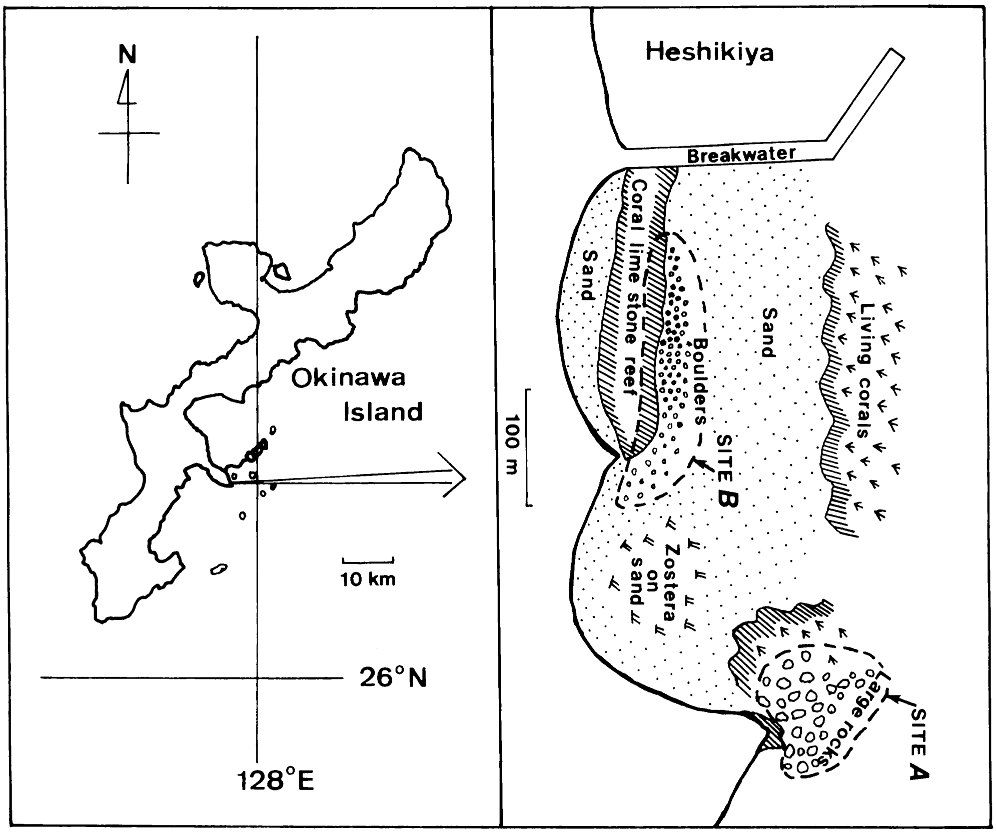

Fig. 4. Study area in Heshikiya, Okinawa Island.

Key to the Japanese species of *Neoclinus*

1a. Usually one ocellus (rarely obscure or rarely two) anteriorly on dorsal fin; orbital cirri 3 or 4 (rarely 4) arranged in a single row 2
1b. No ocellus on dorsal fin; orbital cirri 6 or more arranged in plural rows 4
2a. Total cephalic sensory pores 58 to 76 .... *okazakii*
2b. Total cephalic sensory pores 48 to 57 3
3a. Total vertebrae 44 to 46; pectoral fin rays 12 to 14 (mostly 13) .... *chihiroe*
3b. Total vertebrae 47 to 49; pectoral fin rays 13 to 15 (mostly 14)................ *bryope*
4a. Nuchal cirri absent; minimal hypural present; only a row of scales along midline of body........................ *nudus*
4b. A pair of nuchal cirri present; minimal hypural absent; scales widely spaced on most part of trank 5
5a. Orbital cirri 6 to 7 (mostly 7) arranged in two rows; total vertebrae 45 to 49 (rarely 49); pectoral fin rays 12 to 14 (mostly 13) .... *lacunicola*
5b. Orbital cirri 9 to 11 (mostly 9) arranged in three rows in middle part; total vertebrae 49 to 51; pectoral fin rays 13 to 15 (mostly 14) .... *toshimaensis*

Habitat of the two Okinawan species of *Neoclinus*

Both the two species, *N. nudus* and *N. okazakii*, inhabit in rocky reefs in Heshikiya which is located near the tip of the Katsuren Peninsula, Okinawa Island (Fig. 4; 26°18′N, 127°56′E). Between 28 Apr. and 2 May, 1985, observations and samplings were made on these two species there. The study area is subtropical and is washed by the Kuroshio Current. The water temperature rises up to nearly 30℃ in summer and falls down to nearly 19℃ in winter (Nakamura, 1983, 1984).

The observed two species clearly separated their habitats. While *N. nudus* was observed exclusively in Site A, *N. okazakii* was in Site B (Fig. 4).

Site A was carrying large rocks (2 to 5 m in diameter) on the rocky slope of a spur in depths ranging from 3 to 8 m. Most of the rocks rose sheer from the rocky floor. The rocks frequently bore some smaller living shrub corals on the upper surface. Strong current caused by waves and tides flowed around the rocks. *N. nudus* was observed exclusively in clam holes on the upper surface of the rocks. To my surprise, 11 of 16 fishes collected were from a single rock whose upper surface was only about 2 square meters in area. The rock was subjected to the most strong current in the observed area.

Site B was a transition area from gentle rocky slopes to the sandy bottom in depths ranging from 1 to 4 m. The area was washed by somewhat turbid waters at the time of observation and living corals were absent there. The wave action was moderate to weak but the current flowing in the area was rather strong though somewhat less than that in Site A. *N. okazakii* was mostly observed in clam holes on variable sized boulders (0.3 to 1 m in diameter) carried in the area. They were seldom observed in clam holes on basal rocky slope.

In Site A, the only other fish observed in clam holes was one individual of *Ecsenius lineatus* (Blenniidae). It was observed on a rock situated in the deeper end of the spur where *N. nudus* was never found. In Site B, no other fish was observed in clam holes.

The above noted topography inhabited by these two species are rather particular in the Okinawa Islands. In the observations on the blennioid fishes conducted in March, 1973 and October, 1974 in the ordinary coast of coral reefs in the Okinawa Islands, fishes of *Neoclinus* could not be found at all and, instead of them, many blenniids were observed in clam holes or barnacle tests (Fukao, 1980) or in tide pools (*Omobranchus loxozonus*, *Rhabdoblennius ellipes*, *Praealticus amboinensis tanegasimae*, *P. margaritarius*, *Salarias luctuosus*, *Istiblennius edentulus*, *I. cyanostigma* and *I. lineatus*). While many blenniids including small hole dwellers and tide pool dwellers were recorded, fishes of *Neoclinus* were not recorded from the waters around Sesoko Island in spite of intensive observations and collections on shorefishes (Yoshino and Nishijima, 1981). These facts indicate that *N. nudus* and *N. okazakii* restricted to the rather particular habitat which is exceptionally unoccupied by blenniids in the subtropical waters of Okinawa.

N. nudus also occurs in the subtropical waters of Taiwan (Stephens and Springer, 1971). Stephens and Springer (1971) noted that the specimens of *N. nudus* (11 inds.) were collected from a single rock in a cove and that, although several collections were made in the same cove on different days before and after the day the specimens were obtained, no other specimens of *Neoclinus* were taken or observed. This note is consistent with the present study. The habitat of this species is believed to be extremely narrow. It is very interesting that the water movement encountered there (strong laminar flow) is similar to that encountered in cliff faces in upper subtidal of very exposed rocky reefs (VE habitat) of temperate Shirahama where *N. lacunicola* and young of *N. toshimaensis*, consisting of a group with *N. nudus*, exceptionally co-occurred (Fukao and Okazaki, 1987).

N. okazakii also occurs in the temperate waters of Shirahama. In Shirahama, they mainly inhabit VE habitat but they also occur in other habitats, especially frequently in ME-VE habitat (upper subtidal rocky reefs with the degree of exposure intermediate between ME (upper subtidal of moderately exposed rocky reefs) and VE habitats) (Fukao and Okazaki, 1987). In the present study area, the condition of the water movement around their nests is similar to that encountered in ME or ME-VE habitats of Shirahama. Fukao and Okazaki (1987) estimated that settlement site selection at the recruitment is not so rigid in this species and the other two members of *N. bryope* complex, but is rigid in *N. lacunicola* and *N. toshimaensis* which may select settlement site at recruitment depending on the nature of water movement. If so, the status of water movement may be a rather insignificant factor for the habitat restriction noticed in *N. okazakii*. Worthy of note is that the fish are almost restricted to the holes on boulders instead of holes directly on the basal rocky substratum as mostly observed in Shirahama. Clam holes directly on the basal rocky substratum are frequently occupied by a squilla, *Gonodactylus chiragra* in the study area. It is plausible that the habitat width in this species may be reduced by competition with other animals for nest holes in the subtropical waters of Okinawa.

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沖縄産コケギンポ属魚類とその生息場所

深尾隆三

沖縄産コケギンポ属 *Neoclinus* 魚類は従来コケギンポ *N. bryope* として報告された2個体のみが知られていた．本研究の結果，これら2個体を含め沖縄島から採集された38個体の魚類はアライソコケギンポ *N. okazakii* であることが判明した．ほかに従来台湾からのみ記録されていたハダカコケギンポ *N. nudus* が沖縄島より得られたので，これら2種を沖縄島産の標本に基づき再記載し，沖縄産のアライソコケギンポは和歌山県白浜産の標本と，ハダカコケギンポは台湾産の標本および白浜のイワアナコケギンポ *N. lacunicola* とトウシマコケギンポ *N. toshimaensis* との比較を行なった．また沖縄島平敷屋において，これら2種はその生息場所をはっきりと異にしているのが観察された．そして穴居性を示す両種はいずれも沖縄諸島の岩礁，珊瑚礁において繁栄するイソギンポ科 Blenniidae 魚類に占められていない特殊な生息場所を利用しているものと考えられた．

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