

## Two New North Pacific Skates (Rajidae) and a Revised Key to *Bathyraja* in the Area

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**Abstract** Two new species of the skates, *Bathyraja hubbsi* and *B. pseudoisotrachys* are described from the North Pacific. Among the North Pacific *Bathyraja*, *B. hubbsi* most closely resembles *B. violacea* Suvorov in possessing a disc without thorns, a median tail thorns irregularly spaced, and minute fine prickles covering the entire dorsal surface. The two species are distinguished from each other by their dorsal color pattern, proportional measurement of tail in relation to total length, clasper components, and number of precaudal vertebrae. *Bathyraja pseudoisotrachys* has long been confused with *B. isotrachys* (Günther) by many Japanese authors, but is distinguished from other North Pacific *Bathyraja* by dorsal squamation and unique clasper components such as two clefts, terminal bridge and ridge. *Bathyraja kincaidii* Garman is synonymized with the valid species *B. interrupta* Gill et Townsend. *Bathyraja abyssicola* Gilbert and *B. trachura* Gilbert are redescribed in detail. Provisionally, 21 species of the genus *Bathyraja* are recognized in the present study from this region, and a revised key is given to the North Pacific species of the genus.

Although many authors have dealt with the taxonomy of the North Pacific skates from the end of the 19th century to the present, the taxonomy of these skates still remains uncertain and confused largely due to their ambiguous specific characters and insufficient information on the morphological variation of each species. Recently Ishiyama and Ishihara (1977) described five species of the genus *Bathyraja* from the western North Pacific. However, a key to the North Pacific species of *Bathyraja* was not given in that study. The aim of the present study is to review the species of the genus *Bathyraja* of the North Pacific with descriptions of two new species and re-descriptions of four rare species, and to provide a key using many specimens which were newly obtained from the region (Figs. 1, 2). The type specimens of all the species of the North Pacific *Bathyraja* were examined, except for that of *B. smirnovi* Soldatov et Pavlenko whose type specimen was lost (Dr. V. Dolganov, pers. comm.). Since Stehmann (in press) elevated the subgenus *Notoraja* to the generic rank, *Bathyraja (Notoraja) tobitukai* (Hiyama) is not included in the present study.

This study also aims to solve the difficulty in the identification of *Bathyraja* species mostly on the basis of external characters. Additionally, characters of the neurocranium and male claspers are described for comparison. Although some authors stated the necessity for observation of the pelvic girdle and the scapulocoracoid in clas-

sifying the skates, these characters are not employed in the present study.

### Methods

Methods for counts and measurements follow Hubbs and Ishiyama (1968) and Ishiyama and Ishihara (1977). The size of the specimens in the present study is given in total length (TL). As for the squamation of the body and tail, the authors follow Stehmann and Bürkel (1984) who precisely defined the thorns, thornlets and prickles. Clasper terminology follows Stehmann (1970) and Hulley (1972). The "spur" of Ishiyama (1958b, 1967), Ishiyama and Hubbs (1968) and Ishiyama and Ishihara (1977) and the "knife" of Ishiyama (1958b, 1967) are called here "sentinel", since the former two terms and the latter term mean components of the clasper which are all formed by the accessory terminal 1 cartilage. However, since the nature of the "sentinel" and the "knife" are considerably different (distal region of the former is rod-like, whereas that of the latter is axe-like and covered with lamellar integument), the latter term is called "knife-like sentinel" in order to discriminate it from simple "sentinel". The "pseudosiphon-like groove" found in *B. minispinosa* (Ishiyama and Ishihara, 1977: figs. 3A, 15) is termed here "pseudosiphon 2" and the groove-like component usually called "pseudosiphon" (see Ishiyama, 1958b: fig. 3) is referred to as "pseudosiphon 1". The "pseudosiphon 1"

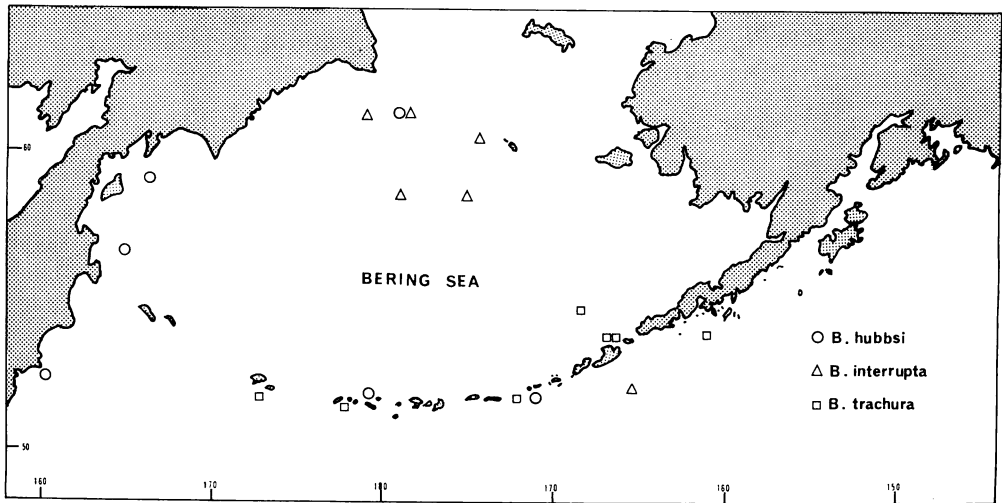


Fig. 1. Map of the Bering Sea showing localities for three species of the genus *Bathyraja*.

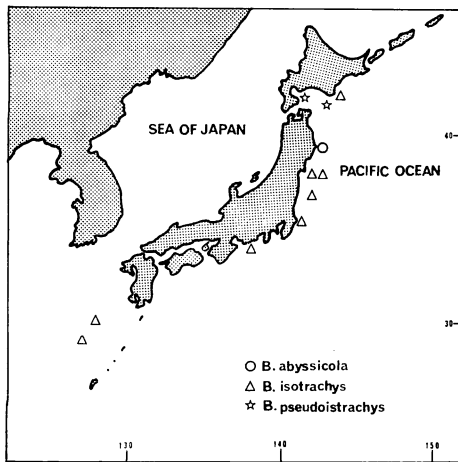


Fig. 2. Map of the Japanese waters showing localities for three species of the genus *Bathyraja*.

is formed by the dorsal terminal 1 cartilage and d.d. muscle usually, whereas the "pseudosiphon 2" is formed by the dorsal terminal 1 cartilage and axial cartilage in *B. minispinosa*. The "pseudosiphon 1" occurs in most North Pacific species of *Bathyraja* and *Rhinoraja* (also see Ishiyama, 1958b: fig. 3). The "pseudosiphon 2" is not known in any other species of *Bathyraja*, nor elsewhere within the family Rajidae so far as the authors are aware. However, the pseudosiphon of *Rhinobatos schlegelii* (family Rhinobatidae) and *Platyrhina sinensis* (family Platyrhin-

idae) are homologous with the pseudosiphon 2 of *B. minispinosa*. Judging from these evidences, it may be said that the pseudosiphon 1 of the Rajidae has an origin different from that of the pseudosiphon of the other batoids (Hulley, 1972: fig. 12), though Ishiyama (1958b) interpreted the pseudosiphon 1 of the Rajidae having gradually rotated outwards. Further functional and comparative studies must be made to allow a better evaluation. The "terminal bridge" exists in *B. pseudoisotrachys* sp. nov. (see Fig. 19). Hulley (1972) stated that the "terminal bridge" should not be recognized as a separate and distinct clasper component by some reasons. In *B. pseudoisotrachys* sp. nov. the "terminal bridge" is formed by the process arising from the dorsal terminal 2 cartilage and differs in the strict sense from its definition by Stehmann (1970). However, in the present study the process arising from the dorsal terminal 2 cartilage in *B. pseudoisotrachys* is regarded as the terminal bridge.

Measurements and terminology of the egg-capsule follow Ishiyama (1958a) and Ishiyama and Ishihara (1977). Vertebral counts were made on radiographs. Coloration was observed mostly on fresh-caught specimens, but for some species formalin preserved specimens had to be used unavoidably. English names of the species are after Miller and Lea (1972), Robins *et al.* (1980) and Allen (1983).

The abbreviations for the institutions are as

follows: AMNH—American Museum of Natural History; BMNH—British Museum (Nat. Hist.); CAS—California Academy of Sciences; FAKU—Faculty of Agriculture, Kyoto University; FFHU—Faculty of Fisheries, Hokkaido University; FSFRL—Far Seas Fisheries Research Laboratory; FUMT—Department of Fisheries, University Museum, University of Tokyo; HUMZ—Laboratory of Marine Zoology, Faculty of Fisheries, Hokkaido University; MCZ—Museum of Comparative Zoology, Harvard University; MTUF—Museum, Tokyo University of Fisheries; NRFRL—Nansei Regional Fisheries Research Laboratory; NSMT—National Science Museum, Tokyo; SIO—Scripps Institution of Oceanography; SOSC—Smithsonian Oceanographic Sorting Center; SU—Natural History Museum, Stanford University; USNM—United States National Museum of Natural History; ZIAS—Zoological Museum, Academy of Sciences, U.S.S.R.; ZUMT—Department of Zoology, University Museum, University of Tokyo.

Collectors of the study material were: Dr. O. Kibesaki, former President of the Shimonoseki Univ. of Fisheries; Mr. S. Kishida, NRFRL; Dr. K. Teshima and Mr. T. Sasaki, FSFRL; Mr. K. Kobayashi; former staff of FFHU; Dr. K. Nakaya, Dr. T. Sasaki, Dr. M. Toyoshima and Mr. T. Kanayama, HUMZ.

*Bathyraja abyssicola* (Gilbert, 1895)

(Japanese name: Chihiro-kasube; English name: Deepsea skate)  
(Fig. 3)

*Raja abyssicola* Gilbert, 1895: 396, pl. 20 (type locality: Albatross St. 3342, off Queen Charlotte Is.).

*Raia abyssicola*: Goode and Bean, 1895: 509 (listed); Garman, 1913: 344 (compiled).

*Raja abyssicola*: Jordan and Evermann, 1896: 76 (compiled); Fowler, 1930: 502 (listed); Jordan, Evermann and Clark, 1930: 26 (listed); Grey, 1956: 100 (compiled); Wilimovsky, 1958: 21 (in key); McAllister, 1960: 6 (listed, Pacific coast of Canada); Clemens and Wilby, 1961: 90, fig. 28 (descr.; range); Grinols, 1965: 25 (listed, British Columbia to Oregon); Miller and Lea, 1972: 46 (descr.; fig.; in key); SIO 62-692, west coast of North Coronado Is.; USNM 73913, North Pacific); Quast and Hall, 1972: 4 (listed, British Columbia to Oregon); Hart, 1973: 55 (descr.; fig.; range; refer.).

*Bathyraja abyssicola*: Stehmann, 1978: 53 (refer. only); Nakaya, 1983: 54 (descr., Pacific coast of northern

Japan; fig.; range; remarks); Allen, 1983: (in key).

**Material examined.** USNM 48623, holotype, adult male, 1,143 mm TL, west of Moresby I., 52°39'N; 132°38'W, 2,906 m depth, Sept. 3, 1890, collected by Charles H. Gilbert; HUMZ 78181, adult male, 1,178 mm TL, off Yamada, 39°27'N; 142°33'E, 1,100 m depth, Sept. 22, 1978, collected by K. Nakaya. The capture locality is shown in Fig. 2.

**Diagnosis.** A large-sized species with a maximum total length of about 1,200 mm. Greatest disc width in posterior half of disc 56.5% of disc length. Tail length longer than precaudal body length in adults. Small caudal fin developed only on dorsal end of tail. One or three median nuchal thorns and 25–31 median tail thorns present. No scapular thorns on each shoulder. Both sides of disc and tail armed with minute fine prickles. Both sides of disc and tail light pale brown. Posterior 1/3 of upper surface of clasper with dermal denticles. Pseudosiphon 1 present proximally near outer lateral edge of upper surface of clasper. Inner surface of dorsal lobe of clasper with distinct pseudorhipidion and cleft, of ventral lobe with projection, sentina and knifelike sentinel. Accessory terminal 1 axe-shaped, forming knife-like sentinel. Neurocranium with extremely long rostral appendices, its length 19.5% of the cranial length. Vtr: 37–42, Vprd: 77–78.

**Description.** Meristic counts and morphometric measurements of the holotype and the present

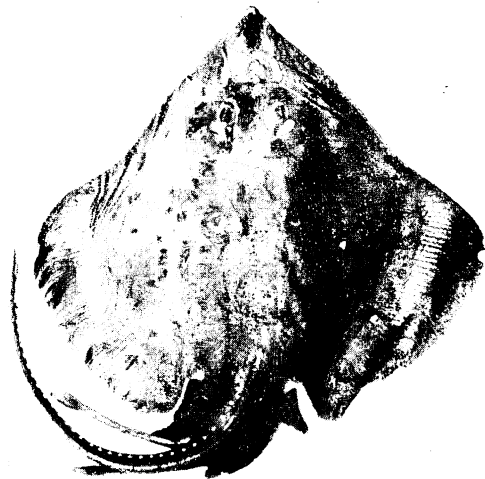


Fig. 3. *Bathyraja abyssicola*. HUMZ 78181, adult male, 1,178 mm TL.

Table 1. Counts and measurements (mm) of *Bathyraja abyssicola*.

	Holotype ♂ USNM 48623	♂ HUMZ 78181	In % of TL
Total length	1143	1178	—
Disc length	570	605	49.9–51.4
Disc width	730	646	54.8–63.9
Snout to maximum disc width	—	342	29.0
Head length	—	232	19.7
Preorbital snout length	185	157	13.3–16.2
Orbit length	33	32	2.7– 2.9
Interorbital width	—	43	3.7
Spiracle length	33	32	2.7– 2.9
Interspiracular width	—	68	5.8
D <sub>1</sub> origin to tail tip	148	124	10.5–12.9
D <sub>1</sub> base length	48	35	3.7– 4.2
D <sub>1</sub> vertical height	—	24	2.0
D <sub>2</sub> base length	46	35	3.7– 4.0
D <sub>2</sub> vertical height	—	25	2.1
Interdorsal distance	13	5.5	0.5– 1.1
Caudal base length	—	51	4.3
Caudal vertical height	—	6.5	0.6
Lateral tail fold length	—	292.5	24.8
Preoral snout length	190	152	12.9–16.6
Mouth width	105	85	7.2–12.4
Prenarial snout length	—	127	10.8
Internarial width	—	87	7.4
Nasal curtain length	—	37	3.1
Over 1st gill slits	—	177	15.0
Posterior pelvic lobe length	87	113	9.6
Anterior pelvic lobe length	—	121	10.3
Clasper length	255	280	22.4–23.8
Precaudal body length	—	578	49.1
Tail length	—	600	50.9
Tooth rows in upper jaw	31	34	
Pseudobranchial folds	—	13.5	
Vtr	37	42	
Vprd	77	78	
Cranium length	—	227	
Rostral cartilage length	98	116	
Prefontanelle length	80	106	
Cranium width	—	126	
Interorbital width	—	42	
Anterior fontanelle length	—	32	
Posterior fontanelle length	—	—	
Rostral appendix length	19.0	44.5	

specimen HUMZ 78181 are given in Table 1.

External features: Disc inverse heart-shaped, its anterior margins rather undulated, convex at level of orbits and concave at level of nape; posterior margins almost straight; greatest disc width in posterior half 56.5% of disc length. Snout moderately produced, preorbital snout length

67.7% of head length; interorbital space not flat, and wider than orbit length; spiracles as large as orbits and separated from each other by twice the distance of their length; pseudobranchial folds 13 (left) and 14 (right). Tail long and stout, its length 103.8% of precaudal body length; the two dorsals equal in size, separated by a distance of

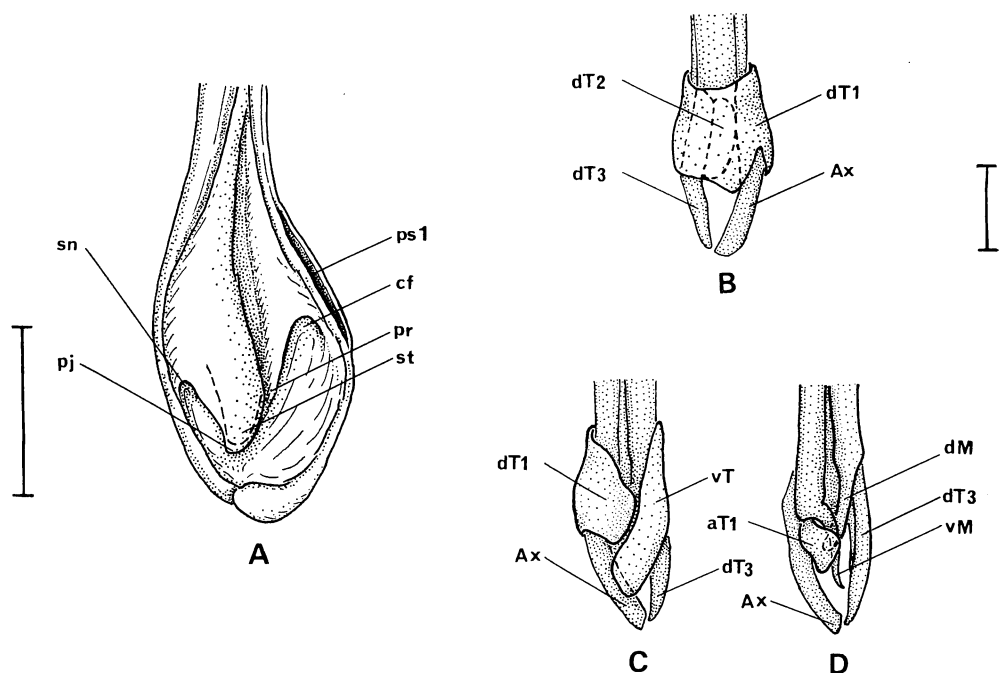


Fig. 4. Clasper of *Bathyraja abyssicola*, HUMZ 78181, left clasper. A, clasper components (clasper groove opened); B, clasper skeleton in dorsal view; C and D, clasper skeleton in ventral view. aT1, accessory terminal; Ax, axial; cf, cleft; dM, dorsal marginal; dT1–dT3, dorsal terminals 1 to 3; pj, projection; pr, pseudorhipidion; ps1, pseudosiphon 1; sn, sentina; st, sentinel; vM, ventral marginal; vT, ventral terminal. Scales indicate 20 mm.

15–27% of  $D_1$  base length; length from  $D_1$  origin to tail tip 20.7% of tail length; postdorsal length 8.5% of tail length; caudal fin low, only developed dorsally, its basal length about half of  $D_1$  base length and its vertical height 37% of its basal length; lateral folds arising at midlength of tail. Mouth weakly arched, with 31–34 parallel rows of pointed teeth in upper jaw; mouth width 55.9% of preoral snout length; internarial width 68.5% of prenarial snout length; nasal curtain length 29.1% of prenarial snout length, its rear margins fringed with 8–9 fimbriae; distance between first gill slits 76.3% of head length.

One or three median nuchal thorns and 25–31 median tail thorns present; no scapular thorns on either shoulder; interdorsal thorns absent in the specimen of HUMZ 78181, but single interdorsal thorns present in the type. Both sides of disc and tail armed with minute fine prickles; prickles absent in dorsal tip of snout, orbits, dorsal surface of anterior pelvic lobes, ventral surfaces of posterior pelvic lobes and ventral surface of anterior 1/4 of

tail; prickles covering densely middorsal area of disc and tail. Posterior 1/3 of dorsal surface of clasper with prickles (dermal denticles). Alar thorns stout, not retractable fully developed, arranged in 24–26 longitudinal and in 7 transverse rows.

Coloration: Dorsal ground color light pale brown, with some small faints dark spots; anterior edge of spiracles whitish. Ventral ground color same as dorsally; tail somewhat darker; areas around mouth and cloaca, anterior margins of the five gill slits and nostrils, and tip of clasper whitish.

Clasper: Clasper fully developed with oval tip, its length 46.6% of tail length. Dermal denticles developed on posterior 1/3 of dorsal surface; pseudosiphon 1 present proximally near outer lateral edge of dorsal lobe, its length 8% of clasper length; inner surface of dorsal lobe with distinct pseudorhipidion and cleft; inner surface of ventral lobe with projection and sentina; knife-like sentinel placed within sentina (Fig. 4A).

Clasper skeleton consists of 3 dorsal terminal,

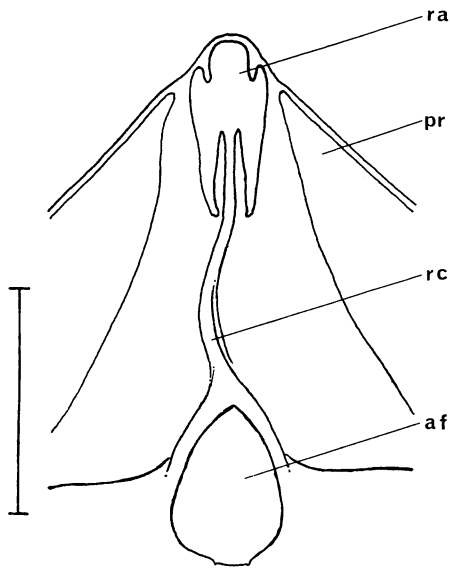


Fig. 5. Rostral region of the neurocranium of *Bathyraja abyssicola*, holotype, USNM 48623, 1,143 mm TL. af, anterior fontanelle; pr, pectoral radials; ra, rostral appendices; rc, rostral cartilage. Scale indicates 50 mm.

1 accessory terminal, ventral terminal and axial cartilages: dorsal terminal 1 (dT1) large, almost quadrangular with notch at inner edge; dT1 curved around the axial onto ventral side and connected with ventral terminal, forming pseudosiphon 1 at its outer edge; dorsal terminal 3 (dT3) long and slender, extending from level of hypopyle to tip; dorsal terminal 2 (dT2) oval, its length half of the length of dT3; dT2 united at both ends with dT3 and axial respectively; tip of dorsal marginal (dM) pointed, forming pseudorhipidion externally; ventral terminal (vT) long and leaf-like, overlying tip of ventral marginal and accessory terminal 1; tip of ventral marginal (vM) pointed, forming projection externally; accessory terminal 1 (aT1) axe-like, lying beneath tip of vM and forming knife-like sentinel externally; axial (Ax) spatulate distally (Fig. 4B-D).

Neurocranium after radiograph: Length of rostral cartilage 51.1% of cranial length; prefontanelle rostral length 46.7%; cranium width 55.5%; least interorbital width 18.5%; length of anterior fontanelle 14.1%; length of rostral appendices 19.6%. Rostral cartilage abruptly tapering near its broad base; rostral appendices long,

its length 38.4% of the length of rostral cartilage; anterior fontanelle spade-shaped (Fig. 5).

**Remarks.** Some differences are found between the present specimen (HUMZ 78181) and the holotype, i.e. interdorsal distance short without thorns in the former (long with thorns in the latter); nuchal thorns one (three); anterior part of lower surface of disc prickly (smooth); sides of tail without enlarged prickles (with a band of enlarged prickles). However, the comparison of the clasper structures between the two confirms that the HUMZ specimen is conspecific with the holotype.

This species together with *B. aguja* and *B. spinosissima* are quite unique among the North Pacific *Bathyraja* in that both sides of the disc and tail are covered with prickles, though in *B. aleutica* the anterior part of the lower surface of the disc is covered with prickles. The development of prickles on the lower surface is considered a common specialized character of *B. abyssicola*, *B. aguja* and *B. spinosissima*. However, *B. abyssicola* has one or three median nuchal thorns on the disc, whereas the latter two species have no thorns on the disc.

**Distribution.** Apart from the records of the holotype and the specimen of HUMZ 78181, the following additional records of this species are known: USNM 73913, North Pacific; SIO 62-692, north of Coronado I., (32°25.2'N; 117°27.6'W, 1,281 m depth). These records show that this species occurs widely from the Pacific coasts of the Baja California Peninsula, Pacific coast of British Columbia to the Pacific coast of northern Japan at depths from 1,100 to 2,906 m. The record at the depth of 2,906 m is the deepest catch of any skate or ray (Grey, 1956).

*Bathyraja hubbsi* sp. nov.

(New Japanese name: Doro-kasube; New

English name: Mudskate)

(Fig. 6A, B)

?*Raja trachura* (not Gilbert, 1891): Walford, 1935: 56, fig. 51 (Santa Barbara I.; off Central Alaska); Roedel and Ripley, 1950: 74, fig. 57 (copied from Walford, 1935).

**Holotype:** MTUF 23936, adult male, 621 mm TL, Bering Sea, 61°11'N; 179°0'W, 400 m depth, July 4, 1963, collected by O. Kibesaki.

**Paratypes (9):** 2 adult males: MTUF 23937, 578 mm TL, off Cape Lopatka, North Pacific, detailed data unknown, collected by K. Kobayashi; HUMZ 67578, 545 mm TL, Bering Sea, 52°08'N; 171°40'W, 450 m

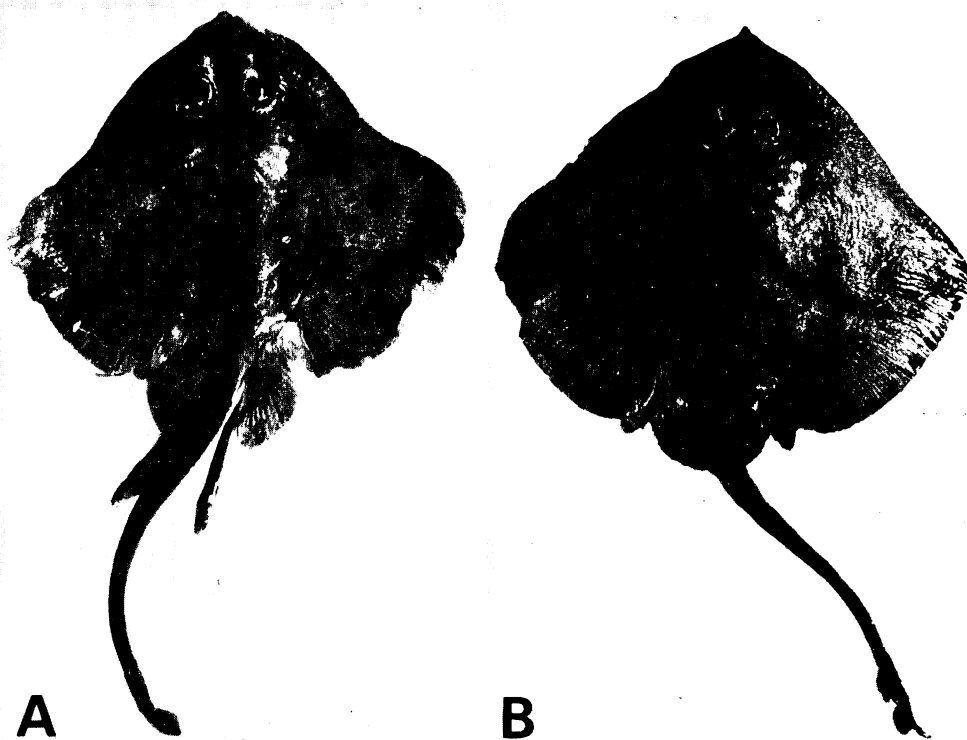


Fig. 6. *Bathyraja hubbsi* sp. nov. A, holotype, MTUF 23936, adult male, 621 mm TL; B, paratype, MTUF 23940, adult female, 697 mm TL.

depth, June 9, 1977, collected by T. Kanayama; 6 adult females: MTUF 23939, 703 mm TL, Bering Sea, 59°10'N; 166°19'E, 450 m depth, May 22, 1963; MTUF 23940, 697 mm TL, collected with MTUF 23939; MTUF 23941, 620 mm TL, Bering Sea, 52°52'N; 160°06'E, 190 m depth, July 12, 1963; MTUF 23942, 614 mm TL, collected with MTUF 23941, all collected by O. Kibesaki; HUMZ 67577, 634 mm TL, collected with HUMZ 67578; HUMZ 68490, 601 mm TL, Bering Sea, 52°03'N; 179°0'E, 590 m depth, June 7, 1977, collected by T. Kanayama; 1 young female: HUMZ 67575, 310 mm TL, collected with HUMZ 67578. The capture localities are shown in Fig. 1.

**Diagnosis.** A medium-sized species with a maximum total length of about 650 mm in males and 700 mm in females. Greatest disc width in posterior half of disc 54.2–59.3% of disc length. Preorbital snout length 56.7–66.7% of head length. Orbit length almost equal to interorbital space and spiracle length. Tail longer than precaudal body length in adults. Small caudal fin developed only on dorsal end of tail. Thorns absent on disc. Indistinct median tail thorns arranged in a row and irregularly spaced. Minute fine prickles

covering entire dorsal surface of disc and tail. Dorsal side of disc mottled with many white markings without ring. Obvious white markings on each pectoral center and a small oval spot aside each orbit. Pseudosiphon 1 present proximally near outer lateral edge of upper surface of clasper. Inner surface of dorsal lobe of clasper with pseudorhipidion and cleft, that of ventral lobe with projection, sentina and sentinel. Tip of accessory terminal 1 needle-like, forming sentinel externally. Rostral cartilage short, its length 39.8% of the cranial length. Vtr: 30–33, Vprd: 69–74.

**Description.** Meristic counts and morphometric measurements of the holotype and the nine paratypes are given in Table 2.

**External features:** Disc rhombic, anterior margins concave at level of nape in males, nearly straight in females; posterior margins of disc convex in both sexes; greatest disc width in posterior half 54.2–59.3% of disc length. Snout soft, flexible and short, preorbital snout length 56.7–66.7% of head length; orbit length almost equal to interorbital space and spiracle length;

Table 2. Counts and measurements (mm) of *Bathyraja hubbsi* sp. nov.

	Holotype		Paratypes								In % of TL
	♂ MTUF 23936	♂ MTUF 23937	♂ HUMZ 67578	♀ MTUF 23939	♀ MTUF 23940	♀ MTUF 23941	♀ MTUF 23942	♀ HUMZ 67577	♀ HUMZ 68490	♀ HUMZ 67575	
Total length	621	578	545	703	697	620	614	634	601	310	—
Disc length	310	295	265	367	363	331	318	315	300.5	—	48.6–53.4
Disc width	368	294	316	433	423	397	362	343	362	192	50.9–64.0
Snout to maximum disc width	174	166.5	155.5	208	207	180	184	187	163	—	27.1–30.0
Head length	104	104	94	129	129	118	108	118	108	—	16.7–19.0
Preorbital snout length	62	59	56	85	85	74	72	76	67	—	10.0–12.2
Orbit length	24	23	22	21	24	23	23	21	19.5	—	3.2–4.0
Interorbital width	20	21	17	22.5	24	21	19	21.5	19	—	3.1–3.6
Spiracle length	19	20	19	23	22	20	19	19	20	—	3.0–3.5
Interspiracular width	37	38	31	42	42	39	37	38.5	36.5	—	5.7–6.6
D <sub>1</sub> origin to tail tip	74	69	75.5	78	83	75	68	80	81	—	11.0–13.9
D <sub>1</sub> base length	26	27.5	25	30	28	28	26	29.5	27	—	4.0–4.8
D <sub>1</sub> vertical height	18	17	14.6	22	14	19	15	14	13.5	—	2.0–3.1 <sup>†</sup>
D <sub>2</sub> base length	24	20.5	26	27	29	25	21	25.5	28	—	3.4–4.8
D <sub>2</sub> vertical height	19	17.5	13.5	20	16	18	14	14	12	—	2.5–3.1
Interdorsal distance	6	0	1.5	0	4	7	2	3.5	2	—	0–1.0
Caudal base length	16	22	22	20.5	20	19	16	19	22	—	2.6–4.0
Caudal vertical height	4	7	5	7	4	6	4	5.5	5	—	0.6–1.0
Lateral tail fold length	140	200	145	205	156	140	135	145	195	—	22.0–34.6
Preoral snout length	60	60	54	77	81	77	75	72	66.5	—	9.7–12.4
Mouth width	44	43	37.5	45	44	41	42	39.5	38	—	6.2–7.4
Prenarial snout length	50	47	41.5	63	71	62	60	57.5	54	—	7.6–10.2
Internarial width	41	36	32	43	43	38	39	35	35	—	5.5–6.6
Nasal curtain length	21	21.5	17.5	22	21	23	22	21.5	18.5	—	3.0–3.6
Over 1st gill slits	111	103	98	132	129	122	114	114	113	—	17.8–19.7
Posterior pelvic lobe length	83	77.5	71	71	74	64	62	49	52	—	7.7–13.4
Anterior pelvic lobe length	94	78.5	79.5	99.5	103	92	94	88.5	84	—	13.6–15.5
Clasper length	155	148.5	124.5	—	—	—	—	—	—	—	22.8–25.0
Precaudal body length	270	264	240	327	322	294	286	292	270	—	43.5–47.4
Tail length	351	315	305	376	375	326	328	341	331	—	52.6–56.5
Tooth rows in upper jaw	32	28	34	30	34	30	29	31	31	—	—
Pseudobranchial folds	13	—	—	14	12	13	14	—	—	—	—
Vtr	31	32	33	30	30	31	32	32	30	34	—
Vprd	70	70	69	74	70	69	73	71	74	70	—
Cranium length	—	103	—	—	—	—	—	—	—	—	—
Rostral cartilage length	—	41	—	—	—	—	—	—	—	—	—
Prefontanelle length	—	34	—	—	—	—	—	—	—	—	—
Cranium width	—	62	—	—	—	—	—	—	—	—	—
Interorbital width	—	22	—	—	—	—	—	—	—	—	—
Anterior fontanelle length	—	22	—	—	—	—	—	—	—	—	—
Posterior fontanelle length	—	9	—	—	—	—	—	—	—	—	—
Rostral appendix length	—	13	—	—	—	—	—	—	—	—	—



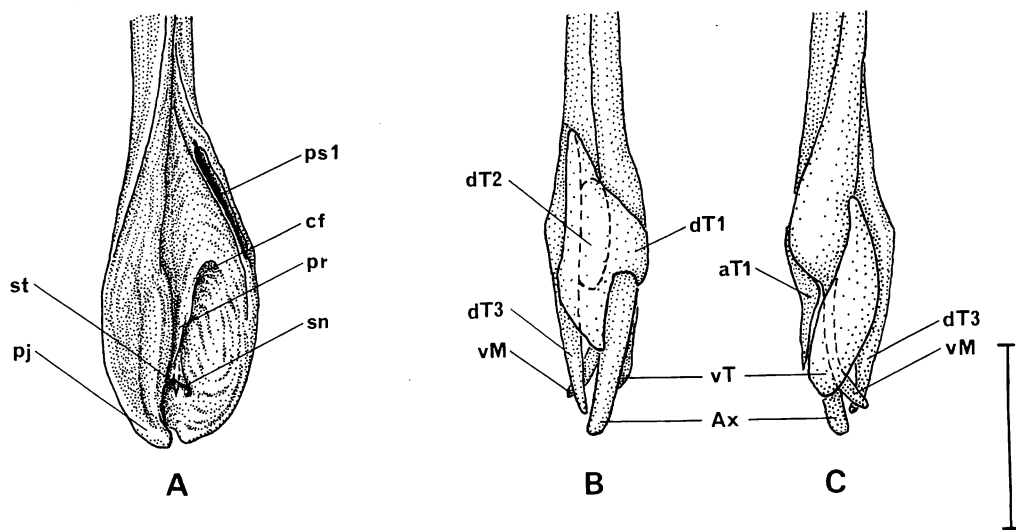


Fig. 7. Clasper of *Bathyraja hubbsi* sp. nov., paratype, MTUF 23937, left clasper. A, clasper components (clasper groove opened); B, clasper skeleton in dorsal view; C, clasper skeleton in ventral view. aT1, accessory terminal 1; Ax, axial; cf, cleft; dT1–dT3, dorsal terminals 1 to 3; pj, projection; pr, pseudorhipidion; ps1, pseudosiphon 1; sn, sentina; st, sentinel; vM, ventral marginal; vT, ventral terminal. Scale indicates 20 mm.

interorbital space about half of interspiracular width; pseudobranchial folds 12–14. Tail long and stout, its length 52.6–54.6% of TL; the two dorsals equal in size, separated by a distance of 0–23% of  $D_1$  base length; length from  $D_1$  origin to tail tip 19.5–26.7% of tail length; postdorsal length 4.6–7.3% of tail length; caudal fin low, only developed dorsally, its basal length 62–88% of  $D_1$  base length and its vertical height 20–34% of its basal length; lateral folds developed in posterior 39.9–64.4% of tail. Mouth weakly arched, with 28–34 parallel rows of pointed teeth in upper jaw in males, 29–34 rows of flattened teeth in quincunx in upper jaw in females; mouth width 53.2–73.3% of preoral snout length; internarial width 60.9–82.0% of prenarial snout length; nasal curtain length 29.6–45.7% of prenarial snout length, its rear margins fringed; distance between first gill slits 96.6–106.7% of head length.

Dorsal surface of disc with minute fine prickles, similar prickles and indistinct thorns on tail: 14–21 median irregularly spaced indistinct tail thorns from origin of tail to first dorsal; no thorns on disc and in interdorsal space; minute fine prickles densely and entirely covering dorsal surface of disc and tail, except for anterior pelvic lobes; prickles sparse on orbits and posterior pelvic lobes

in both sexes, and prickles sparse above gill chamber and in pectoral centers of adult males; ventral side smooth. Alar thorns of males stout, hook-like and not retractable, arranged in 15–17 longitudinal and in 5–8 transverse rows.

Coloration: Dorsal ground color dark brown; inner margin of orbit whitish; faint and some distinct white spots on pectoral centers, a small white spot at side of each orbit; two or three transverse white crossbars on tail; snout translucent lighter. Ventral ground color white; corners of disc and posterior margin of pelvics pale brown; tip of anterior pelvic lobes and mouth area yellowish; margin of cloaca darkish; tail partly to almost entirely dark brown.

Clasper: Clasper slender, its length 40.8–47.6% of tail length; pseudosiphon 1 present proximally near outer lateral edge of dorsal lobe; inner surface of dorsal lobe with pseudorhipidion and cleft; inner surface of ventral lobe with projection and sentina; rudimentary sentinel placed within sentina (Fig. 7A).

Clasper skeleton consists of 3 dorsal terminal, 1 accessory terminal, ventral terminal and axial cartilages: dorsal terminal 1 (dT1) large, with notch at inner edge and blunt distal end which supports outer lateral margin of pseudosiphon 1;

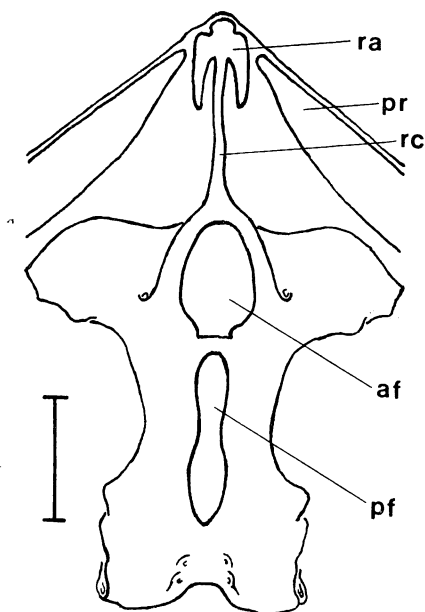


Fig. 8. Neurocranium of *Bathyraja hubbsi* sp. nov., paratype, MTUF 23937 adult male. af, anterior fontanelle; pf, posterior fontanelle; pr, pectoral radials; ra, rostral appendices; rc, rostral cartilage. Scale indicates 20 mm.

dT1 not attached to ventral terminal; dorsal terminal 3 (dT3) long, extending from level of hypopyle to tip of clasper; dorsal terminal 2 (dT2) oval, its length half length of dT3; dT2 united at both ends with dT3 and axial respectively; tip of dorsal marginal (dM) needle-like, forming pseudorhipidion externally; ventral terminal (vT) leaf-like, overlying tip of ventral marginal and accessory terminal 1; tip of ventral marginal (vM) pointed, forming projection externally; accessory terminal 1 (aT1) needle-like, forming sentinel externally; axial (Ax) spatulate distally (Fig. 7B, C).

Neurocranium (measurements based on the specimen of MTUF 23937): Length of rostral cartilage 39.8% of cranial length; prefontanelle rostral length 33.0%; cranium width 60.2%; least interorbital width 21.4%; length of anterior fontanelle 21.4%; length of posterior fontanelle 28.2%; length of rostral appendices 12.6%. Rostral cartilage nearly straight; anterior fontanelle spade-shaped; posterior fontanelle gourd-shaped (Fig. 8).

**Remarks.** This species closely resembles *B. violacea* in the following respects: 1) disc without thorns; 2) median tail thorns irregularly spaced;

3) minute fine prickles densely and entirely covering dorsal surface; 4) ventral side of tail partly to almost entirely dark brown. However the two species differ from each other in the following respects: 1) tail length always longer than precaudal body length in adults of *B. hubbsi* (tail length usually less than precaudal body length in adults of *B. violacea*); 2) area above gill chamber prickly (usually smooth); 3) white markings present on disc (dusky vermiculated pattern present on disc); 4) clasper with pseudosiphon 1 (without pseudosiphon 1); 5) Vtr: 30–33 (Vtr: 33–37).

The figures of *R. trachura* in Walford (1935) and Roedel and Ripley (1950) greatly resemble *B. hubbsi*, or at least are not identical with *B. trachura*. The questionable specimens of these authors should be reexamined.

**Distribution.** This species occurs in the Bering Sea and along the Pacific coast of the Kamchatka Peninsula at depths from 190 to 590 m (see Fig. 1).

**Etymology.** This species is named in honour of the late Dr. Carl L. Hubbs for his great work in ichthyology.

***Bathyraja interrupta* (Gill et Townsend, 1897)**

(Japanese name: Beringu-kasube; English name: Bering skate)

(Fig. 9A, B)

*Raja interrupta* Gill and Townsend, 1897: 232 (type locality: Bering Sea, without illustr.).

*Raja interrupta*: Jordan and Evermann, 1898: 2751 (compiled); Jordan and Gilbert, 1899 (listed, Bering Sea); Berg, 1911: 96 (in key; descr. in Russian, Maoka, Sakhalin, June 6, 1901, no. 12602, male); Fowler, 1930: 502 (listed); Jordan, Evermann and Clark, 1930: 26 (listed); Soldatov and Lindberg, 1930: 22 (compiled); Taranetz, 1937: 51 (in key); Fowler, 1941: 394 (compiled); Wilimovsky, 1954: 281 (listed); Wilimovsky, 1958: 21 (in key); Quast and Hall, 1972: 4 (listed); Ricker, 1973: 228 (listed); Robins *et al.*, 1980 (listed).

*Raja kincaidii* Garman, 1908: 254 (type locality, Friday Harbor, Washington, MCZ 1261; without illustr.).

*Raja kincaidii*: Garman, 1913: 343, pl. 17 (redescr.).

*Raja interrupta*: Garman, 1913: 345 (compiled).

*Raja kincaidii*: Schultz and DeLacy, 1935: 368 (record; range); Schultz, 1937: 235 (descr. of 19 specimens, Oval Bay, British Columbia; Albatross Sts. 4507; 4414; Alden Bank, Washington); Roedel and Ripley, 1950: 74 (descr.; range); McAllister, 1960: 6 (listed, Pacific coast of Canada); Clemens and

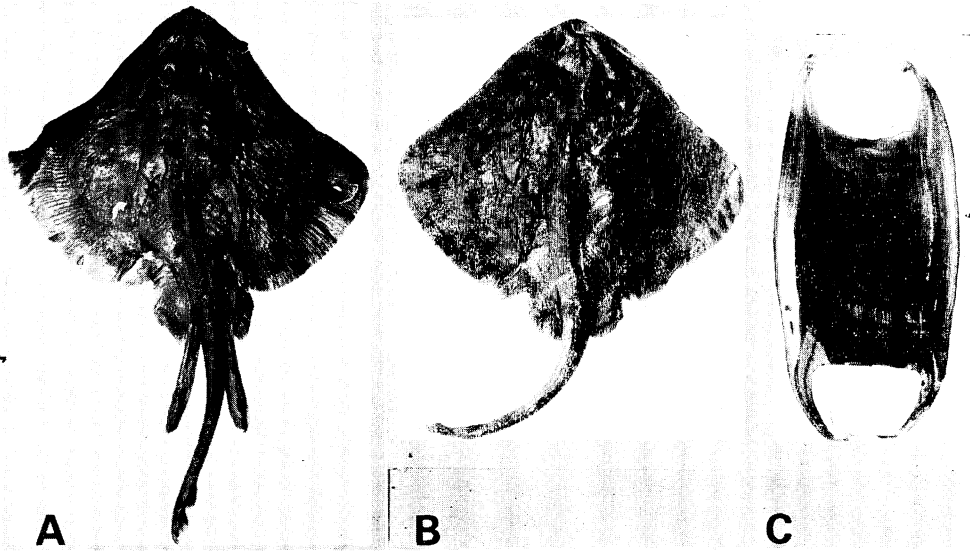


Fig. 9. *Bathyraja interrupta*. A, MTUF 22008, adult male, 671 mm TL; B, MTUF 22022, adult female, 723 mm TL; C, egg-capsule, extracted from MTUF 22014, 82 mm in length excluding horn.

Wilby, 1961: 88, fig. 27 (descr.; range, southern California to Gulf of Alaska); Miller and Lea, 1972: 44 (descr., Cortez Bank to Unalaska I.; fig.; in key). *Raja kincaidi*: Schultz, 1936: 132 (in key); Alverson, 1951: 86 (record, near Luck Point, Clarence Strait); Wilimovsky, 1954: 281 (listed, Alaska); Wilimovsky, 1958: 21 (in key); Wilimovsky, 1964: 179 (listed, Northwest Unalaska I.); Grinols, 1965: 26 (listed, Alaska to southern California); Quast and Hall, 1972: 4 (listed, Bering Sea to California); Hart, 1973: 58 (descr.; fig.; egg-capsule; range); Robins *et al.*, 1980: 14 (listed). *Breviraja interrupta*: Lindberg and Legeza, 1959: 130, fig. 82 (compiled); Ueno, 1965: 417 (refer. only); Okada and Kobayashi, 1968: 41, pl. 5 (descr., Bering Sea); Ueno, 1971: 70 (listed, South Sakhalin; Kuril Is.); FSFRL, 1972: 96, fig. NORPAC-6 (descr., Bering Sea). *Breviraja kincaidi*: Cox, 1963: 278, fig. 6 (egg-capsule). *Bathyraja interrupta*: Garrick and Paul, 1974: 361, table 5 (refer. only); Ishiyama and Ishihara, 1977: 88, table 5 (comparison); Allen, 1983: (in key). *Bathyraja kincaidii*: Stehmann, 1978: 53 (refer. only); Eschmeyer *et al.*, 1983: 50, fig. 11, pl. 4 (descr.). *Bathyraja kincaidi*: Allen, 1983: (in key). **Material examined.** USNM 48760, holotype, young male, 428.5 mm TL, Bering Sea; USNM 48761, paratype, young female, 200 mm DW; MCZ 1261, holotype of *Raja kincaidii*, young female, 303.4 mm TL, Friday Harbor, Washington, collected by Trevor Kincaid; 9 adult males: MTUF 22006, 705.5 mm TL, Bering Sea, 58°30'N; 175°10'W, 300 m depth, Oct.

20, 1962; MTUF 22007, 706 mm TL, collected with MTUF 22006; MTUF 22008, 671 mm TL, collected with MTUF 22006; MTUF 22009, 695 mm TL, collected with MTUF 22006; MTUF 22010, 728 mm TL, collected with MTUF 22006; MTUF 22011, 672 mm TL, collected with MTUF 22006; MTUF 22012, 686 mm TL, Bering Sea, 61°07'N; 179°10'W, 245 m depth, July 2-3, 1963; MTUF 22013, 639 mm TL, Bering Sea, 53°44'N; 165°10'W, 230 m depth, May 29, 1963, all collected by O. Kibesaki; HUMZ 34497, 610 mm TL, near Queen Charlotte I., 58°42'N; 135°42'W, 300 m depth, Jan. 15, 1970, collected by T. Sasaki; 10 adult females: MTUF 22014, 793 mm TL, collected with MTUF 22006; MTUF 22015, 658.5 mm TL, collected with MTUF 22006; MTUF 22015, 658.5 mm TL, collected with MTUF 22006; MTUF 22016, 735 mm TL, collected with MTUF 22006; MTUF 22017, 721 mm TL, collected with MTUF 22006; MTUF 22018, 712 mm TL, Bering Sea, 60°59'N; 174°33'W, 400 m depth, May 30, 1963; MTUF 22019, 718 mm TL, Bering Sea, 61°11'N; 179°0'W, depth unknown, July 4, 1963; MTUF 22020, 690.5 mm TL, Bering Sea, 58°31'N; 170°0'W, 340 m depth, May 22, 1963; MTUF 22021, 723 mm TL, Bering Sea, 53°44'N; 165°10'W, 230 m depth, May 29, 1963; MTUF 22022, 723 mm TL, collected with MTUF 22021, all collected by O. Kibesaki; HUMZ 34524, 573 mm TL, near Vancouver I., 51°18'N; 130°15'W, 310-334 m depth, May 15, 1969, collected by T. Sasaki; 1 young female: HUMZ 34469, 444.5 mm TL, near Vancouver I., 51°22'N; 130°03'W, 400 m depth, May 18, 1969, collected by T. Sasaki. The capture localities are

shown in Fig. 1.

**Diagnosis.** A medium-sized species with a maximum total length of about 700 mm in males and 800 mm in females. Greatest disc width in posterior half of disc 54.1–69.9% of disc length. Snout moderately produced, preorbital snout length 62.7–69.8% of head length. Interorbital space narrow, mostly not more than orbit length. Tail length more than or less than precaudal body length. The bases of the two dorsals not confluent. Small caudal fin developed only on dorsal end of tail. One or two scapular thorns on each shoulder. A row of median thorns from nape to first dorsal mostly interrupted on trunk. Fine prickles covering densely almost entire dorsal surface of disc and tail. No prickles developed on ventral side of disc and tail, except for anteriormost tip of snout. Dorsal ground color dark brown, ventral ground color white. Dorsal side of disc sometimes mottled with white markings in adults. Dorsal side of disc covered with numerous scattered dark specks in young. Underside of tail mostly darkish and thus marked off from whitish disc. Pseudosiphon 1 absent. Inner surface of dorsal lobe of clasper with pseudorhipidion and cleft, that of ventral lobe with projection, sentina and sentinel; projection protruding and forming outer angle of clasper tip. Neurocranium with relatively long rostral cartilage, its length 52.4% of the cranial length. Cranium width relatively narrow, 49.4% of the cranial length. Keel of egg-capsule wide, its width 15.3–20.6% of the least width of egg-capsule. Vtr: 29–35, Vprd: 60–73.

**Description.** Meristic counts and morphometric measurements of the holotype and the other material are given in Table 3.

External features: Disc rhombic, its greatest width in posterior half 54.1–69.9% of disc length. Snout moderately produced, preorbital snout length 62.7–69.8% of head length; interorbital space not flat, and narrow, its width usually not more than orbit length; spiracles as long as orbits; pseudobranchial folds 12–14. Tail length shorter or longer than precaudal body length, 46.6–53.9% of TL; the two dorsals equal in size, separated by a distance of 7–61% of  $D_1$  base length; length from  $D_1$  origin to tail tip 20.8–28.8% of tail length; postdorsal length 4.4–8.5% of tail length; caudal fin low, only developed dorsally, its basal length more than half of  $D_1$  base length and its vertical

height 18–41% of its basal length; lateral folds developed in posterior 39.2–88.5% of tail. Mouth nearly straight, with 20–29 parallel rows of pointed teeth in upper jaw in males, 23–30 rows of flattened teeth in quincunx in upper jaw in females; mouth width 34.3–52.6% of preoral snout length; internarial width 54.8–74.5% of prenarial snout length; nasal curtain length 29.8–44.6% of prenarial snout length, its rear margins fringed; distance between first gill slits 82.2–97.2% of head length.

Dorsal side of disc and tail rough with both thorns and fine prickles: one or two scapular thorns on each shoulder; median thorns continuous from nape to first dorsal in the specimens of HUMZ 34497 and 34524, but interrupted on trunk in other specimens; 17–30 median tail thorns regularly spaced; one interdorsal thorns may be present; patterns of prickles varies; prickles absent on anterior pelvic lobes and claspers in all specimens; prickles present or absent on orbits, above gill chamber and in pectoral centers; other areas densely or sparsely covered with fine prickles. Ventral side smooth, except for prickly anteriormost tip of snout. Alar thorns of male stout, hook-like and not retractable, arranged in 19–22 longitudinal and in 4–5 transverse rows.

Coloration: Dorsal ground color dark brown in adults, lighter brown in young; dorsal surface of disc mottled here and there with white markings and three or more lighter crossbars on tail in some adult specimens; dorsal side of disc scattered with numerous dark specks in young. Ventral side of disc white, but darkish around cloaca, at margins of pectorals and distal tips of pelvics; brown median band along entire tail length.

Clasper: Clasper length 49.2–59.6% of tail length; pseudosiphon 1 absent; inner surface of dorsal lobe with pseudorhipidion and cleft; inner surface of ventral lobe with projection, sentina and sentinel; projection conspicuously protruding, forming outer angle of tip (Fig. 10A).

Clasper skeleton consists of 3 dorsal terminal, 1 accessory terminal, ventral terminal and axial cartilages: dorsal terminal 1 (dT1) like a spatula with a long shaft; dT1 with notch at anteromedial edge; dT1 not forming pseudosiphon 1 externally; dorsal terminal 3 (dT3) blade-like, long, extending from level of hypopyle to tip of clasper; dT3 with a longitudinal groove at center; dorsal terminal 2 (dT2) oval, its length half length of

Table 3. Counts and measurements (mm) of *Bathyraja interrupta*.

	Holotype	Paratype										
	♂ USNM 48760	♀ USNM 48761	♀ MCZ 1261	♂ MTUF 22006	♂ MTUF 22007	♂ MTUF 22008	♂ MUTF 22009	♂ MTUF 22010	♂ MTUF 22011	♂ MTUF 22012	♂ MTUF 22013	♂ HUMZ 34497
Total length	428.5	—	303.4	705.5	706	671	695	728	672	686	639	610
Disc length	—	—	154.6	391.5	370	363	370	396	370	376	334	311
Disc width	—	200	173.6	486	463	449	455	502	457	456	424	392.5
Snout to maximum disc width	—	—	84.0	214	252	189	208	217	211	263	186	168
Head length	77.0	—	59.7	142	134	133	137	137	133	141	119	113
Preorbital snout length	46.0	—	36.1	91	84	84.5	94	88	87	90	74	71
Orbit length	17.2	14.0	12.5	24	22	20	20	27	22	22.5	28	23.5
Interorbital width	15.0	12.5	11.2	25	23	27	20	24	25	22	23	20
Spiracle length	16.0	11.2	9.3	22	21	19	19	22	22	23	21	19
Interspiracular width	28.1	23.0	20.1	42	44	44	43	42	41	41	30	38
D <sub>1</sub> origin to tail tip	—	—	40.3	74	77	98	88	92	89	83	83	86.5
D <sub>1</sub> base length	—	—	13.0	—	30	29	29	30	29	28.5	28	28.5
D <sub>1</sub> vertical height	—	—	6.6	—	22	21	26	18	20	19	18	16
D <sub>2</sub> base length	—	—	12.4	—	27	30	27	28	31	26	28	23
D <sub>2</sub> vertical height	—	—	5.5	—	18.5	19	17.5	18	18	18	16	15
Interdorsal distance	—	—	4.7	—	2	10	11	8	5	17.5	7	9
Caudal base length	—	—	9.1	—	19	29	20	25	24	20	17	25
Caudal vertical height	—	—	2.8	—	7	7	7	5	7	6	3	4
Lateral tail fold length	—	—	139	205	215	210	140	—	145	235	150	270
Preoral snout length	45.5	—	43.5	85.5	87	82	96	96	85	84	77	77
Mouth width	30.5	—	22	37	40	38.5	43	33	34	39.5	36	40.5
Prenarial snout length	—	—	32.6	67.5	65	66	73.5	69	70	74	60	55.5
Internarial width	29.0	—	18.6	48	46	44	46	45	44	49.5	42	41
Nasal curtain length	—	—	13.0	22	29	26	28	28	28	25	24	24.5
Over 1st gill slits	—	—	53.1	129	123	121	117	125	120	127	109	108.5
Posterior pelvic lobe length	48.0	—	31.6	108.5	98.5	92	93	109	104	101	90	78.5
Anterior pelvic lobe length	—	—	45.3	96	98	94	92.5	118	110	97	92	86.5
Clasper length	70.0	—	—	211.5	198.5	194	185.5	207	200	197.5	179	162
Precaudal body length	195.5	—	140.0	350.5	337	331	338	348	333	345	296	281
Tail length	233	—	160.4	355	369	340	357	380	339	341	343	329
Tooth rows in upper jaw	27	—	33	21	22	22	25	—	20	27	22	28
Pseudobranchial folds	—	—	—	14	—	—	12.5	12.5	—	14	—	—
Vtr	30	—	32	32	34	33	33	31	30	34	29	33
Vprd	—	—	69	64	68	62	65	67	68	62	68	67
Cranium length	80	—	60	—	—	—	—	—	—	—	—	—
Rostral cartilage length	30.5	—	28	—	—	—	—	—	—	—	—	—
Prefontanelle length	25.5	—	21	—	—	—	—	—	—	—	—	—
Cranium width	49	—	34	—	—	—	—	—	—	—	—	—
Interorbital width	15	—	11	—	—	—	—	—	—	—	—	—
Anterior fontanelle length	16	—	—	—	—	—	—	—	—	—	—	—
Posterior fontanelle length	23.5	—	—	—	—	—	—	—	—	—	—	—
Rostral appendix length	11	—	—	—	—	—	—	—	—	—	—	—

Table 3. (Continued)

	♀ MTUF 22014	♀ MTUF 22015	♀ MTUF 22016	♀ MTUF 22017	♀ MTUF 22018	♀ MTUF 22019	♀ MTUF 22020	♀ MTUF 22021	♀ MTUF 22022	♀ MTUF 34524	♀ HUMZ 34469	In % of TL
Total length	793	658.5	735	721	712	718	690.5	723	676	573	444.5	—
Disc length	440	362.5	408	424	399	386	379.5	389	376	302	249	51.0-58.8
Disc width	535	447	500	510	477	478	456.5	473	445	357	299	62.3-70.7
Snout to maximum disc width	252	200	222	238	235	220	262.5	235	218.5	160.5	141	27.5-38.3
Head length	169	145	153	168	156	144	147.5	156	146	116	94.5	18.5-22.7
Preorbital snout length	117	101	102	114.5	106	96	100	108	98	76	63.5	11.6-15.9
Orbit length	24	21	26	23	25	25	22.5	20.5	21	23	17	2.8- 4.4
Interorbital width	25	25	30	28.5	27	30	23.5	24	25	18	17	2.9- 4.2
Spiracle length	21	20.5	21	22.5	24	22	24	21.5	20	17	14	2.6- 3.5
Interspiracular width	48	42	47	54	47	47	42	46	43	34.5	29	4.7- 7.5
D <sub>1</sub> origin to tail tip	91.5	71.5	80	86.5	81	86	82	76.5	91	72	56	10.5-14.6
D <sub>1</sub> base length	33.5	26	30	30.5	31	28	29	29	32	23	21.5	3.9- 4.8
D <sub>1</sub> vertical height	20	13	18	17	20	16	14	15.5	16	14	14	2.0- 3.1
D <sub>2</sub> base length	24	27	25	29	25	27	27	23	29	20.5	16	3.0- 4.6
D <sub>2</sub> vertical height	14	14	16	19.5	18	17	13	15	16.5	12	11.5	1.8- 2.7
Interdorsal distance	10	3	8	7.5	8	3	5	4	11	9	5	0.3- 2.6
Caudal base length	22	16	16	21	10	28	22	20	16.5	20	12	1.4- 4.3
Caudal vertical height	6	6.5	5	5.5	5	5	4.5	5	6	4.5	4.5	0.5- 1.0
Lateral tail fold length	330	257.5	232	300	140	—	177.5	277.5	220	170	120	20.1-44.3
Preoral snout length	118	100.5	103	113	107	101	102	—	97	77	63	12.1-15.7
Mouth width	44	44	46	43.5	47	40	43	—	39.5	37	29.5	4.5- 6.6
Prenarial snout length	93	79.5	86	92	86	80	81	85.5	78	63	51	9.1-12.8
Internarial width	51	44	54	50	48	38	46	47.5	44	37	27.5	6.1- 7.3
Nasal curtain length	31	26	27	27.5	26	30	24.5	25.5	26	20	16	3.1- 4.2
Over 1st gill slits	139	125	137	150.5	147	140	127	141	127.5	101	84	16.8-20.9
Postrior pelvic lobe length	96	74.5	96	100	89	91	80.5	75	74	56	51	9.8-15.5
Anterior pelvic lobe length	108	102	—	126	118	130	102	111	104	91	71	13.3-18.1
Clasper length	—	—	—	—	—	—	—	—	—	—	—	26.6-30.0
Precaudal body length	414	332.5	370	382	364	338	351.5	376	352	282	220.5	46.1-53.0
Tail length	379	326	365	339	352	380	339	347	324	291	224	46.6-53.9
Tooth rows in upper jaw	23	27	27	27	28	25	29	—	25	30	24	—
Pseudobranchial folds	13.5	—	13	—	—	—	—	12.5	—	—	—	—
Vtr	34	33	34	34	35	43	34	34	35	35	34	—
Vprd	63	73	70	62	66	69	66	64	60	66	67	—
Cranium length	—	—	—	164	—	—	—	—	—	—	—	—
Rostral cartilage length	—	—	—	86	—	—	—	—	—	—	—	—
Prefontanelle length	—	—	—	80	—	—	—	—	—	—	—	—
Cranium width	—	—	—	81	—	—	—	—	—	—	—	—
Interorbital width	—	—	—	28	—	—	—	—	—	—	—	—
Anterior fontanelle length	—	—	—	30	—	—	—	—	—	—	—	—
Posterior fontanelle length	—	—	—	32	—	—	—	—	—	—	—	—
Rostral appendix length	—	—	—	21	—	—	—	—	—	—	—	—

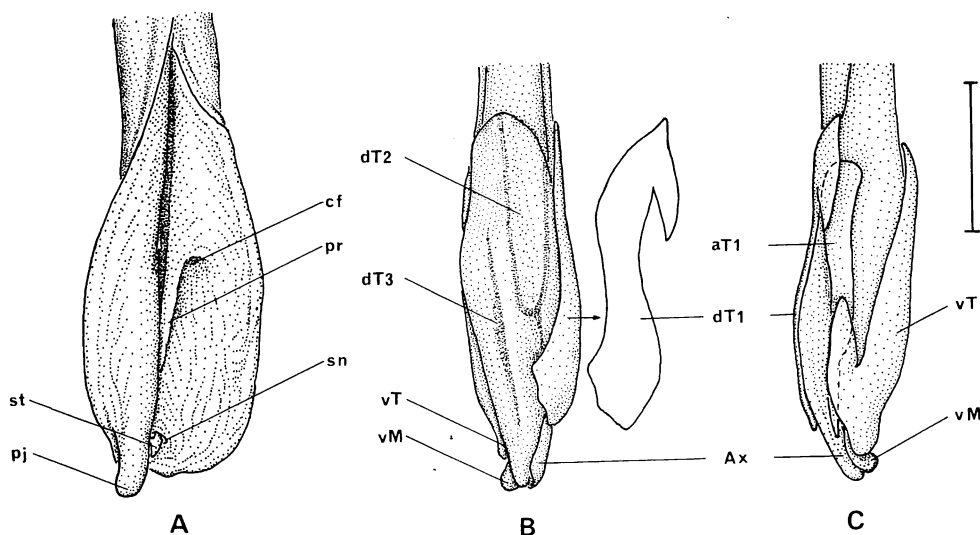


Fig. 10. Clasper of *Bathyraja interrupta*, MTUF 22006, left clasper. A, clasper components (clasper groove opened); B, clasper skeleton in dorsal view; C, clasper skeleton in ventral view. aT1, accessory terminal 1; Ax, axial; cf, cleft; dT1–dT3, dorsal terminals 1 to 3; pj, projection; pr, pseudorhipidion; sn, sentina; st, sentinel; vM, ventral marginal. Scale indicates 20 mm.

dT3; dT2 united at both ends with dT3 and axial respectively; tip of dorsal marginal (dM) pointed, terminating near level of hypopyle and forming pseudorhipidion externally; ventral terminal (vT) J-shaped, firmly connected with midlength of accessory terminal 1; tip of ventral marginal (vM) blunt, extending to tip of clasper, forming projection externally; accessory terminal 1 (aT1) nearly as long as vT; tip of aT1 pointed, forming sentinel externally; axial (Ax) spatulate distally (Fig. 10B, C).

Neurocranium (measurements based on the specimen of MTUF 22017): Length of rostral cartilage 52.4% of cranial length; prefontanelle rostral length 48.8%; cranium width 49.4%; least interorbital width 17.1%; length of anterior fontanelle 18.3%; length of posterior fontanelle 19.5%; length of rostral appendices 12.8%. Rostral cartilage nearly straight; anterior fontanelle spade-shaped; posterior fontanelle gourd-shaped; the two fontanelles almost equal in length (Fig. 11).

Egg-capsule: Egg-capsules extracted from the specimens of MTUF 22014 and 22017. Measurements are given in Table 4. Egg-capsule almost rectangular with horn at each corner; anterior margin roundish, posterior margin nearly straight; tip of anterior horns curved inwards; posterior horns longer than anterior ones; tips of

both anterior and posterior horns filamentous; lateral keel wide, its width 15.3–19.4% of the least width of capsule; surface rough with minute coarse prickles in numerous longitudinal rows; respiratory fissure near midlength of each horn. Ground color of both sides dark brown; lateral keel yellowish brown lighter (Fig. 9C).

**Remarks.** Gill and Townsend (1897) described this species without a figure nor a specific type locality. Many subsequent descriptions of this species by American authors were only quotations of the original description. In 1962, the junior author had a chance to examine the type specimen of this species in the USNM, which was disintegrated into small pieces. Later in 1978, the senior author obtained a radiograph of the holotype from Ms. Susan Jewett, SOSOC. The neurocranium of the holotype was clearly shown in that radiograph. Moreover, an illustration of the holotype drawn by A. H. Baldwin was available to the present authors from Carl L. Hubbs (Fig. 12). These facts make the present authors convinced that the holotype is conspecific with the skate specimens collected from the Pacific coast of Alaska and the whole Bering Sea. Thus, the authors conclude that *B. interrupta* should be recognized as a valid species.

Garman (1908) described *Raja kincaidii* briefly.

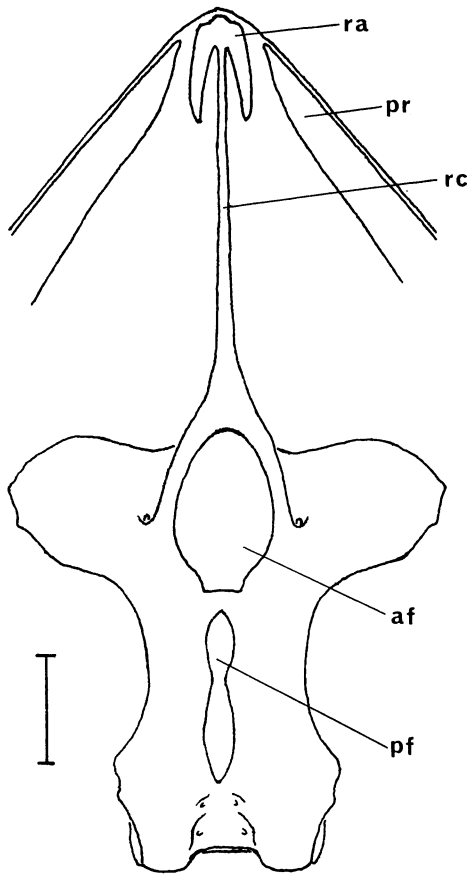


Fig. 11. Neurocranium of *Bathyraja interrupta* MTUF 22017, adult female. af, anterior fontanelle; pf, posterior fontanelle; pr, pectoral radials; ra, rostral appendices; rc, rostral cartilage. Scale indicates 20 mm.

Later, Garman (1913) redescribed this species with a fine figure (see Garman, 1913: pl. 17). In 1962 the junior author had a chance to examine the type specimen of *Raia kincaidii* in MCZ. Later in 1978, the senior author obtained a photograph (Fig. 13) and a radiograph of the type from Drs. William L. Fink and Karsten E. Hartel, MCZ. After comparing these data and the detailed description of the species by Schultz (1937), with our specimens of *B. interrupta*, including young, the present authors conclude that *Raia kincaidii* is a junior synonym of *B. interrupta*. Particularly, the comparison of the structure of the clasper and neurocranium of both species confirms this statement. Comparative data of the two species are given in Table 5.

Table 4. Measurements (mm) of egg-capsules of *Bathyraja interrupta*. Four egg-capsules extracted from the specimens of MTUF 22014 and 22017.

Characters		Mean
Length (without horns)	75.3–83.0	80.3
Width: maximum	66.0–71.5	68.5
minimum	58.5–63.0	61.0
Horn length: anterior	46.0–55.0	51.0
Horn length: posterior	60.0–72.0	69.3
Apron width: anterior	3.5– 5.0	4.3
Apron width: posterior	2.5–11.2	7.5
Keel width	9.0–13.5	10.8

Berg (1911) redescribed *Raja interrupta* on the basis of the specimen collected off Sakhalin. Later a figure of that specimen was published by Lindberg and Legeza (1959). Although the description and figure of the specimen collected by L. S. Berg agree well with *B. interrupta*, the occurrence of this species in the Okhotsk Sea still remains uncertain.

The only congeners known to also possess a clasper with neither pseudosiphon 1 nor terminal bridge among the North Pacific *Bathyraja* are *B. trachouros* and *B. violacea*. However, *B. interrupta* differs from *B. trachouros* in the following respects: 1) ventral surface of tail almost entirely dark in the former, (whereas almost entirely whitish in the latter); 2) projection forming only posterior outer angle of clasper (projection forming posterior margin of clasper) (see Fig. 14); 3) Vtr: 29–35, Vprd: 60–73 (Vtr: 34–36, Vprd: 70–78). *Bathyraja interrupta* also differs from *B. violacea* in the following respects: 1) disc with scapular and median nuchal thorns in the former, (whereas disc without thorns in the latter); 2) disc sometimes mottled with white markings (mottled with dusky vermiculated pattern); 3) projection protruding ventral lobe of clasper (projection not protruding).

The egg-capsules of *Raja kincaidii* illustrated in Cox (1963) and Hart (1973) are quite similar to those of *B. interrupta* in shape, but differ in size. Nine egg-capsules of *R. kincaidii* ranged from 49 to 59 mm in length, whereas those of *B. interrupta* from 81 to 83.5 mm. This seems to be a considerably large variation in view of the fact that the size of egg-capsules in the family Rajidae is conservative infraspecifically (Ishiyama, 1958a). Thus, it still remains doubtful whether or not the difference



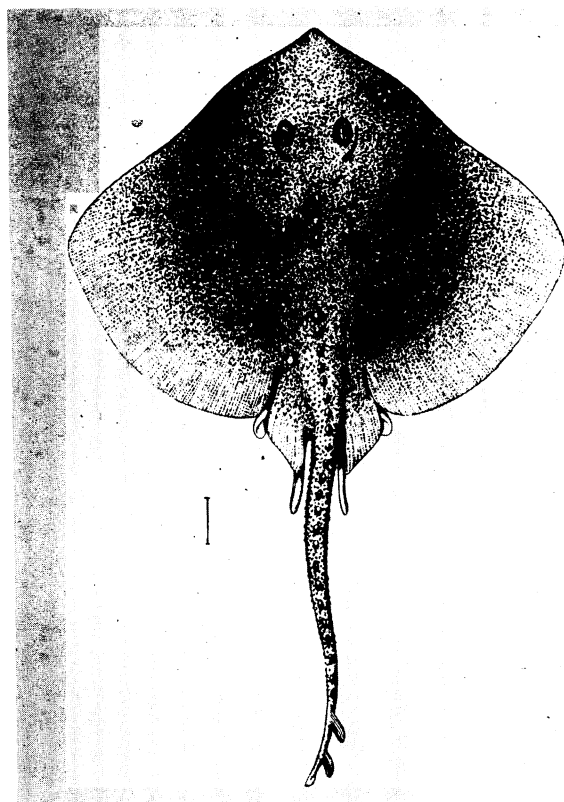


Fig. 12. The holotype of *Raja interrupta* drawn by Mr. A.H. Baldwin, USNM 48760, young male, 428.5 mm TL.

of the size of egg-capsules between the two species can be considered as a geographical variation.

**Distribution.** This species appears to be most abundant in the Bering Sea, though the former information on the species was insufficient. Considering reliable literature references concerned *B. interrupta* and *R. kincaidii*, the range of this species is limited as follows: Pacific coast of California, Oregon, Washington, British Columbia and Alaska (Garman 1908, 1913; Schultz, 1937; Alverson, 1951; Wilimovsky, 1954, 1958; Clemens and Wilby, 1961; Cox, 1963; Grinols, 1965; Miller and Lea, 1972; Hart, 1973; Allen, 1983), and the Bering Sea (Gill and Townsend, 1897; Okada and Kobayashi, 1968; FSFRL, 1972; Allen, 1983). The present study shows that *B. interrupta* is distributed in the Bering Sea at depths from 230 to 530 m.

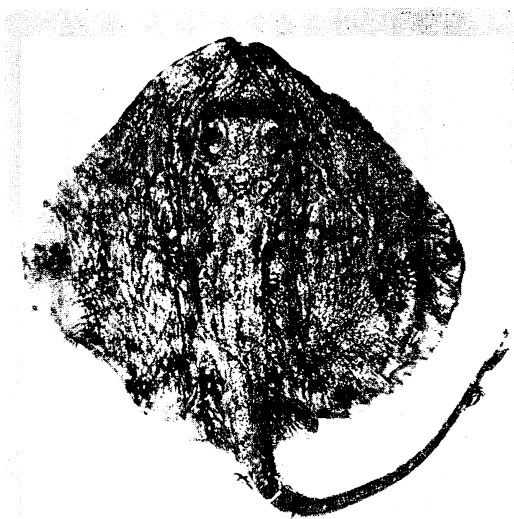


Fig. 13. Holotype of *Raja kincaidii*, MCZ 1261, young female, 303.4 mm TL.

Table 5. Comparison of the measurements and counts of *Raia kincaidii* and *Bathyraja interrupta*. Characters of 19 specimens of *R. kincaidii* after Schultz (1937). Means of the characters of *R. kincaidii* exclude the holotype, MCZ 1261.

Characters	<i>Raia kincaidii</i>			<i>Bathyraja interrupta</i>	
	Holotype MCZ 1261	19 specimens	Mean	Present specimens (MTUF and HUMZ)	Mean
In % of total length:					
Disc width	57.2	58.0–68.9	61.8	62.3–70.7	66.7
Disc length	51.0	44.0–54.9	49.8	51.0–58.8	54.4
Interorbital width	4.2	3.5– 5.9	4.45	2.9– 4.1	3.5
Preorbital snout length	12.6	10.0–13.9	11.5	11.6–15.9	13.5
Tail length	53.1	55.0–60.9	57.9	47.8–54.7	50.6
Precaudal body length	47.1	40.0–45.9	42.4	46.0–53.7	49.9
In % of disc width:					
Disc length	89.1	71.0–83.0	81.0	78.9–84.6	81.6
Preorbital snout length	22.0	16.9–22.2	19.0	15.7–22.8	20.2
In % of preorbital snout length:					
Interorbital width	33.2	30.0–43.5	38.0	21.3–32.0	26.3
Counts:					
Middorsal thorns	28	27–33	30	20–36	25.0
Scapular thorns	1	1–2	1.42	1–2	1.2

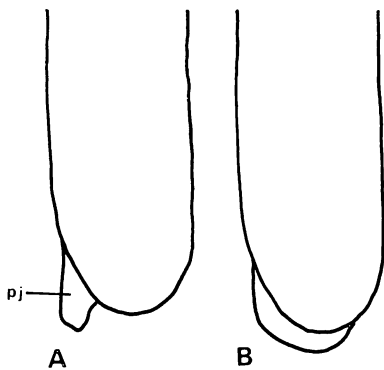


Fig. 14. Distal end of clasper. A, *Bathyraja interrupta*; B, *B. trachouros*. pj, projection.

***Bathyraja isotrachys*** (Günther, 1877)  
 (New Japanese name: Charenja-kasube;  
 New English name: Challenger skate)  
 (Fig. 15)

*Raja isotrachys* Günther, 1877: 434 (type locality: off Shizuoka, North Pacific, without illustr.).

*Raja isotrachys*: Günther, 1887: 7, pl. 3 (redesc.); Jordan and Snyder, 1901: 42 (listed); Jordan and Fowler, 1903: 649 (compiled); Jordan, Tanaka and Snyder, 1913: 27 (catalogue); Jordan and Hubbs, 1925: 109 (in key); Fowler, 1930: 501 (listed); Fowler, 1941: 379 (in part).

*Raia isotrachys*: Goode and Bean, 1895: 508 (listed);

Garman, 1913: 354 (compiled).

*Breviraja isotrachys*: Lindberg and Legeza, 1959: 133, fig. 83 (in part).

*Bathyraja* sp.: Nakaya, 1983: 58 (descr., Pacific coast of northern Japan; fig.; range); Nakaya, 1984: 68 (descr., Okinawa Trough; fig. range).

**Material examined.** BMNH 1887·12·7·3, holotype, immature female, 561.5 mm TL, off Shizuoka, 34°07'N; 138°0'E, 1,028 m depth, green mud bottom, collected by A. Günther; 4 adult males: MTUF 23710, 703.5 mm TL, off Iwaki, 37°09'N; 141°56'E, 900 m depth, Jan. 9, 1978, collected by M. Toyoshima; MTUF 23943, 647 mm TL, off Nansei Is., 28°53'N; 127°18'E, 820 m depth, March 16, 1978; MTUF 23944, 664 mm TL, off Nansei Is., 29°47'N; 128°26'E, 1,000 m depth, Feb. 3, 1978, each collected by S. Kishida; ZUMT 54181, 636 mm TL, off Choshi, 35°40'N; 141°0'E, 450 m depth, Dec. 3, 1978, collected by T. Abe; 3 adult females: MTUF 23711, 723 mm TL, off Kinkazan, 38°0'N; 142°10'E, 800 m depth, Feb. 6, 1978; MTUF 23712, 762 mm TL, off Kinkazan, 38°02'N; 142°29'E, 1100 m depth, Feb. 7, 1978, each collected by M. Toyoshima; HUMZ 67517, 702 mm TL, off Erimo Pen., 41°50'N; 143°50'E, 800 m depth, July 5, 1977, collected by T. Kanayama. The capture localities are shown in Fig. 2.

**Diagnosis.** A medium-sized species with a maximum total length of about 700 mm in males and 750 mm in females. Greatest disc width in posterior half of disc 55.8–63.8% of disc length. Preorbital snout length 66.7–69.8% of head length.