TWO MORE NEW SPECIES OF *GASTROPTERON* FROM JAPAN, WITH FURTHER NOTES ON *G. FLAVUM* T. & B. (GASTROPODA : OPISTHOBRANCHIA)[1)]

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With Plate XXV and 8 Text-figures

This is the authors' second report on the Gastropteridae from Japan. The material for the present study is derived from two sources. One concerns the collection by a dredge made in these four years by Mr. T. KIKUCHI in the vicinities of the Amakusa Marine Biological Laboratory, Kumamoto Prefecture and the Tsuyazaki Fisheries Laboratory, Hukuoka Prefecture, both belonging to the Kyûsyû University. The specimens presented to the authors by the courtesy of Mr. KIKUCHI are preserved in alcohol and found mostly in fine conditions. Although they remind one of *Gastropteron sinense* A. ADAMS imperfectly known from the northern Chinese waters in some aspects, the authors consider it better to treat them as a new species rather than to refer them hazardously to that Chinese species (see the authors' previous discussion on pp. 203 and 205 in the paper of 1964). The other source is in the results of the opisthobranch survey carried out under the supervision of the first author by members of the Biological Club of the Takaoka High School, Toyama Prefecture, in August 1964 on the shore of Ayukawa, a town on the Etizen coast facing the Sea of Japan. Two specimens of *Gastropteron* were obtained by the survey, a single specimen of each of *G. flavum* T. & B. and a new form quite distinctive from any already known species. In this case, the first author had a chance to make accurate figures of these live specimens both in active and resting positions, and confirmed that these gastropterons

1) Contributions from the Seto Marine Biological Laboratory, No. 431; Contributions from the Amakusa Marine Biological Laboratory, No. 182.

assumed in the extended state the characteristic appearance generally known to cephalaspideans.

All of the above-mentioned specimens were examined by the authors as in the previous study, the external features of preserved specimens are mainly due to the last author, while the dissections for jaws and radulae owe to the first author. In addition, the family characters of the Gastropteridae generalized throughout about ten species hitherto be known are given at the end of this paper, together with the systematic relations of the family to others in the order Cephalaspidea which are presented by the first author on his general knowledge on opisthobranchs.

The authors are willing to express their thanks to the following gentlemen for use of specimens: Mr. KIKUCHI of the Amakusa Marine Biological Laboratory and Mr. T. ABE, the leader of the Biological Club of the Takaoka High School.

DESCRIPTIONS OF SPECIES

1. *Gastropteron bicornutum* n. sp.

(Japanese name: *Amakusa-umikotyô*)

(Text-figs. 1–6; Pl. XXV, figs. 1–9)

Holotype: Dredged from the lower brim of the *Zostera* zone outside the Cape Tomoezaki in Tomioka Bay (vicinity of the Amakusa Marine Biological Laboratory), Amakusa, 6.8 m, on April 29, 1962.

Paratypes: Nos. 1–4—Dredgd from the sandy bottom in Tomioka Bay, Amakusa, 18 m, on May 17, 1963.

No. 5—Towed at night in the *Zostera* zone outside the Cape Tomoezaki in Tomioka Bay, Amakusa, on July 6, 1964 (this juvenile and about 4 mm long specimen was found swimming in the water by flapping its parapodia).

Nos. 6–7—Dredged from the sandy mud bottom in the vicinity of Tsuyazaki near Hukuoka, 36 m, on May 9, 1961 (in all 5 specimens were collected from the same station).

Eight specimens, all preserved in alcohol and mostly matured, were examined. The holotype (Text-figs. 1–3; Pl. XXV, figs. 1–2) is 9 mm long, 13 mm wide across the expanded parapodia, and 5 mm high. Paratypes are 3.5 mm (juv.) to 12 mm in body length, the body width measured on expanded parapodia is a little larger than the length. Parapodia are large, generally two times as wide as the dorsal hump on each, roundish in outline and broadest at the middle.

The head region does not extend far beyond the level of the anterior margin of parapodia. The cephalic shield is large and attains about a half of the body length in most specimens. Posteriorly it gets narrowed and forms a sort of funnel as in other species of *Gastropteron* previously recorded. The

dorso-median crest is short, not prolonged to the tip of the funnel. A pair of black eyes are seen through at about the middle of the shield.

The dorsal hump is large, elongated elliptical in outline, much longer than wide, and the rear end passes into a median horn-like protuberance, the ventral protuberance (Text-figs. 1, 3; *v.p.*). The free mantle margin extends

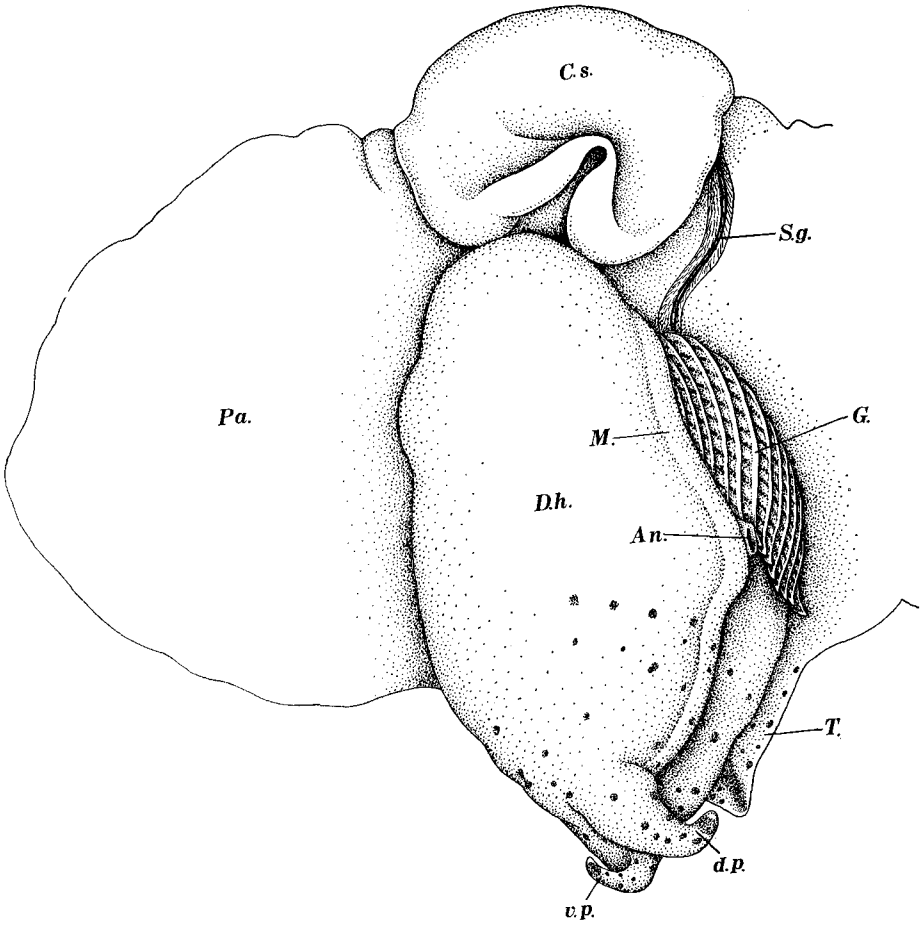

Fig. 1. *Gastropteron bicornutum* n. sp. Dorsal side of holotype, ×13.
For abbreviations see p. 377.

posteriorly as far as near the dorsal base of the ventral protuberance, and forms there another horn-like protuberance, the dorsal protuberance (Text-figs. 1, 3; *d.p.*). The dorsal protuberance is curved to the right side in all specimens but the paratype No. 3. Presumably this is slightly right-sided when alive, and points to the flagellar appendage of the free mantle margin. The dorsal and ventral protuberances are nearly of the same size in the contracted state.

The rest of the surface of the dorsal hump is smooth. The integument of it is rather opaque in matured specimens, but the left anterior portion that is much less opaque.

The borders of the sole are not defined. Only on the paratype No. 1 the sole is bordered on the right side. This border seems, however, to be formed merely by folding of the skin, but not by contraction of pedal muscles. After preservation the tail varies greatly in length in different specimens. Some-

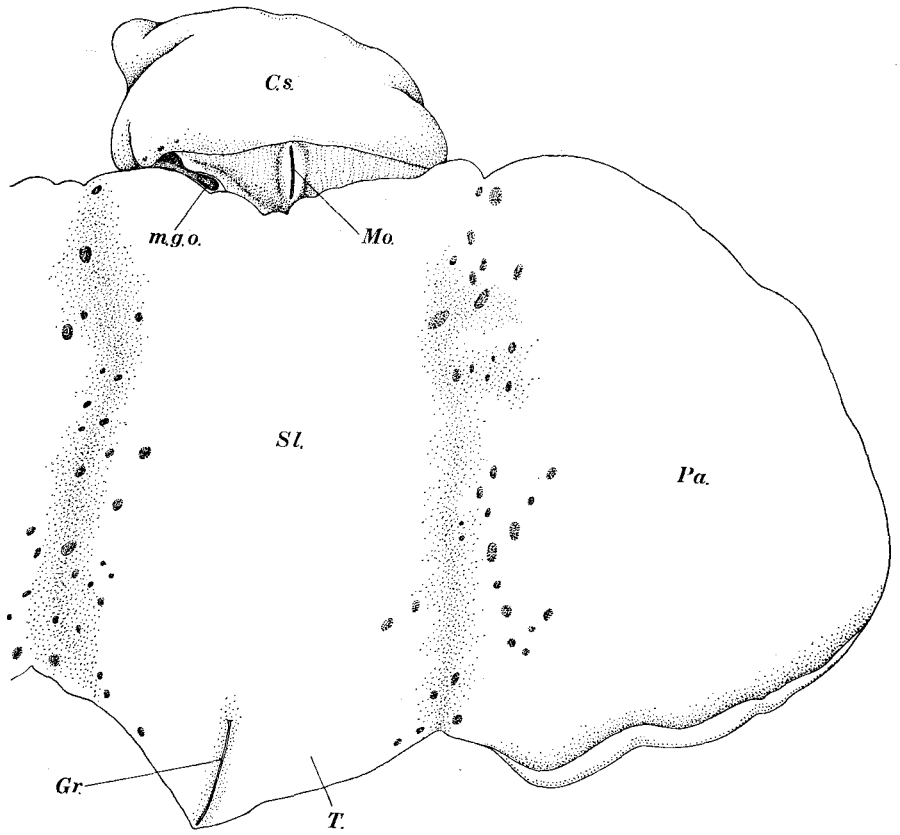

Fig. 2. *Gastropteron bicornutum* n. sp. Ventral side of holotype, ×13.

times it is very short and entirely hidden under the dorsal hump, but in others it may extend posteriorly beyond the rear end of the hump, and taper to the tip (Text-fig. 4, A and B). The pedal gland (Text-fig. 4, A; *p.g.*) forms a whitish elongated gland found on the sole approximately at the level of the posterior edge of parapodia, and there is a distinct longitudinal groove extending from the gland to the tail tip (Text-figs. 2, 4, A; *Gr.*).

Turning again to the free mantle margin, this is nearly four fifths as long

as the dorsal hump (Text-figs. 1, 3; *M.*). The mantle cavity is much deeper in the anterior half than in the posterior, and least remarkable near the middle just behind the anus which opens on a papilla. The nephridial aperture (Text-fig. 3; *Ne.*), marked by a dark pigmentation, is opened on the basal portion of the anal papilla, on its antero-dorsal side.

The ctenidium is very large, nearly half as long as the dorsal hump, and provided with fifteen leaflets in the holotype (Text-figs. 1, 3; *G.*). In the paratypes 7–12 mm long in the preserved state, the number of ctenidium leaflets ranged from 12 to 18. On each of the ctenidium, the leaflets are larger in about the middle one-third of the length of this organ, and diminish in size

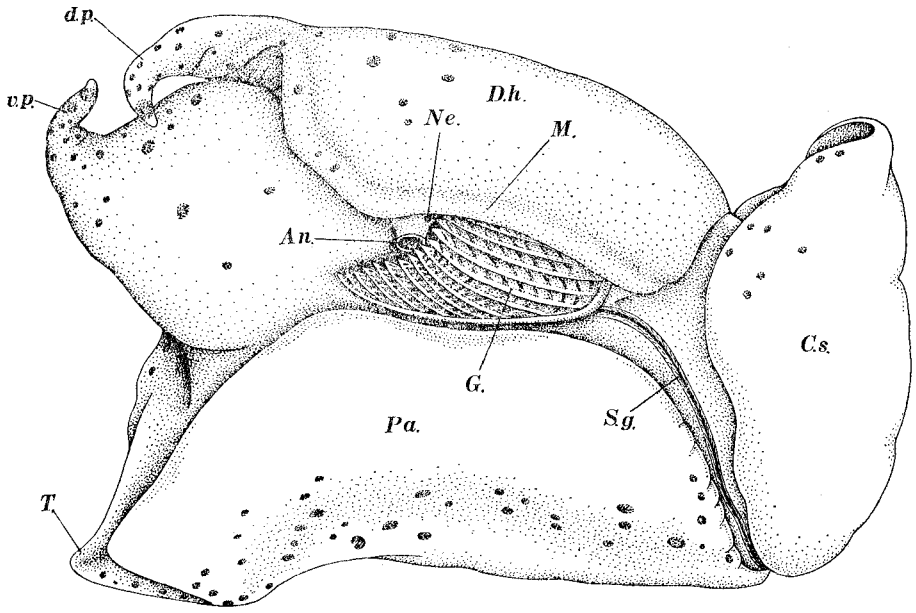

Fig. 3. *Gastropteron bicornutum* n. sp. Right side of holotype, ×13.

towards both proximal and distal ends. The larger leaflets bear each about ten ridges on respective surfaces (Text-fig. 4, C).

The hermaphrodite genital orifice is found just below the ctenidium at its anterior base of liberation. The seminal groove is very prominent in all matured specimens larger than 7 mm in body length. The groove is deep and the edges come close to each other, so that the whole length of the groove assumes a sort of canal opening through a long slit. In general the dorsal edge of the groove is less thickened than the ventral one which sometimes appears highly glandular. The male genital orifice (Text-fig. 2; *m.g.o.*) is close to the right of the mouth slit. The antero-lateral portion of the cephalic

shield was marked on the underside with oblique orange streaks in the holotype in a fresh state of preservation, but any special structure was not found there after. Thus the posterior half of the HANCOCK's organ is superficially obscure.

In the paratype No. 5 (Text-fig. 5, A; Pl. XXV, fig. 6) which is juvenile and 3.5 mm long in preservation, the ctenidium is found still undifferentiated. It takes the form of a small protuberance bearing merely four minute and indistinct prominences on the surface, and the whole structure is hidden beneath the mantle flange. The seminal groove could not be detected at all. The shell was seen through the integument as a whitish object lying near the

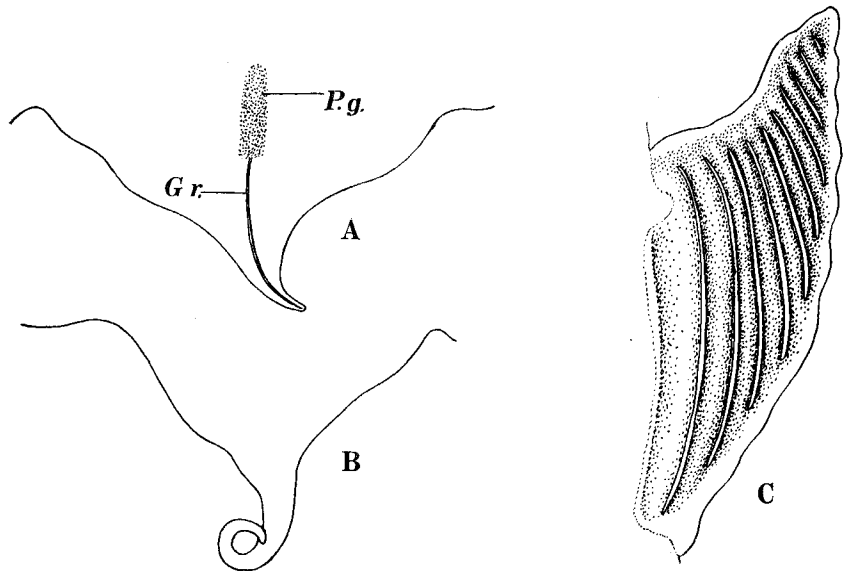

Fig. 4. *Gastropteron bicornutum* n. sp. A—Tail of paratype No. 1, ventral; B—Tail of paratype No. 3, dorsal; C—A leaflet from the middle part of the ctenidium of holotype. The leaflet is attached to the ground membrane of the ctenidium by the left side, ×47.

posterior corner of the dorsal hump, just ventral and right-hand to the base of the ventral protuberance. It is only 500 μ in long diameter, hyaline and very fragile, and seemingly coiled one and a half time (Text-fig. 5, B). The shell could not, however, be found from outside on the remaining specimens.

Two specimens, paratypes No. 4 and No. 7, were dissected for the identification of the jaws and radulae. Generally speaking, these structures do not differ markedly from those in other species of *Gastropteron*. The jaw-plates are yellowish brown and formed each of tiny rods. The radular formula in the paratype No. 4 is 21×4.1.0.1.4 (Text-fig. 6, C–D; Pl. XXV, fig. 5) and that of the paratype No. 7, 13 (+?)×4.1.0.1.4 (Text-fig. 6, G–H; Pl. XXV, figs. 8–9).

The teeth are pale yellowish brown. The first lateral bears a series of 5–10 denticles on the inner edge of the main hook. The marginals are counted to be 4 for each half-row.

According to a brief colour note taken by Mr. KIKUCHI on the living holotype, the animal appears to be yellowish white shaded in places and rather lengthwise with sepia-black (this pigmentation may soon be extracted by alcohol), and the whole surfaces of the cephalic-shield, dorsal hump and parapodia are evenly covered by orange-yellow pigment spots. To sum up the colours of the well-preserved specimens including both holotype and papatypes, the whole body is now of a general ashy yellow or ashy white, and there remain traces of orange-yellow pigment spots especially on the periphery

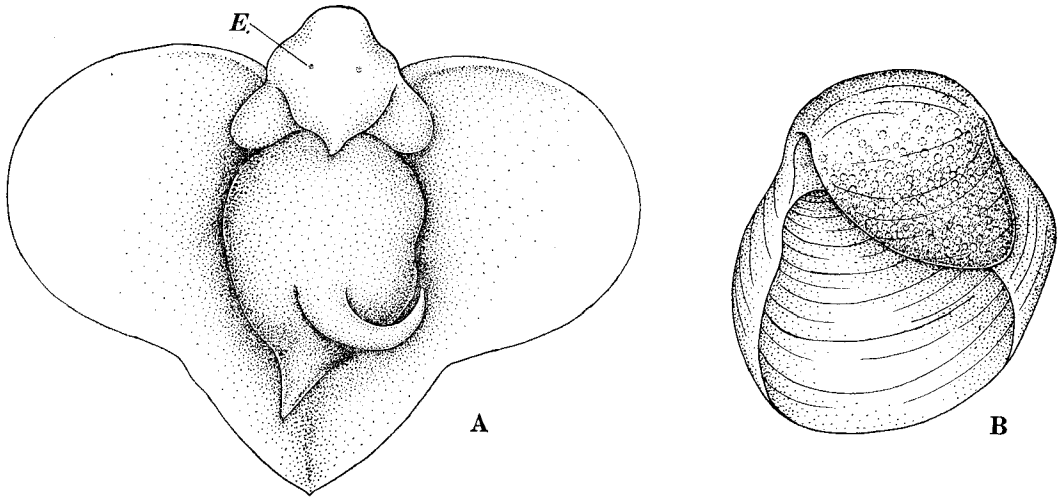

Fig. 5. *Gastropteron bicornutum* n. sp. A—Paratype No. 5, dorsal side, ×18; B—Shell from the same specimen, ×97.

of the cephalic shield, on the extreme anterior and posterior parts of the dorsal hump, and on narrow areas of the lower surface of parapodia along the sole (Text-fig. 2). Also there may be a marked orange-yellow pigmentation at the distal end of the funnel as well as on the tips of both protuberances of the dorsal hump. The dorso-median line of the tail is coloured deeply with orange-yellow. Thus the animals of this species are punctate, but not reticulate, with orange-yellow pigment.

Remarks: The indistinctness of the sole borders, the existence of orange-yellow punctations over the body surface, and the occurrence of animals in shallow waters on sandy or sandy mud bottom are all of our notes to remind one of *Gastropteron sinense* A. ADAMS from North China. It might happen that our specimens pass naturally into the scope of ADAMS' species. At present,

however, such particulars as cited above are not sufficient for justifying immediate identification of them to that species. Moreover, our specimens constitute a well-defined form in the current taxonomy of gastropterons in having two horn-like protuberances of the dorsal hump, and so a new specific name *bicornutum* is provisionally suggested here for this form. A rediscovery

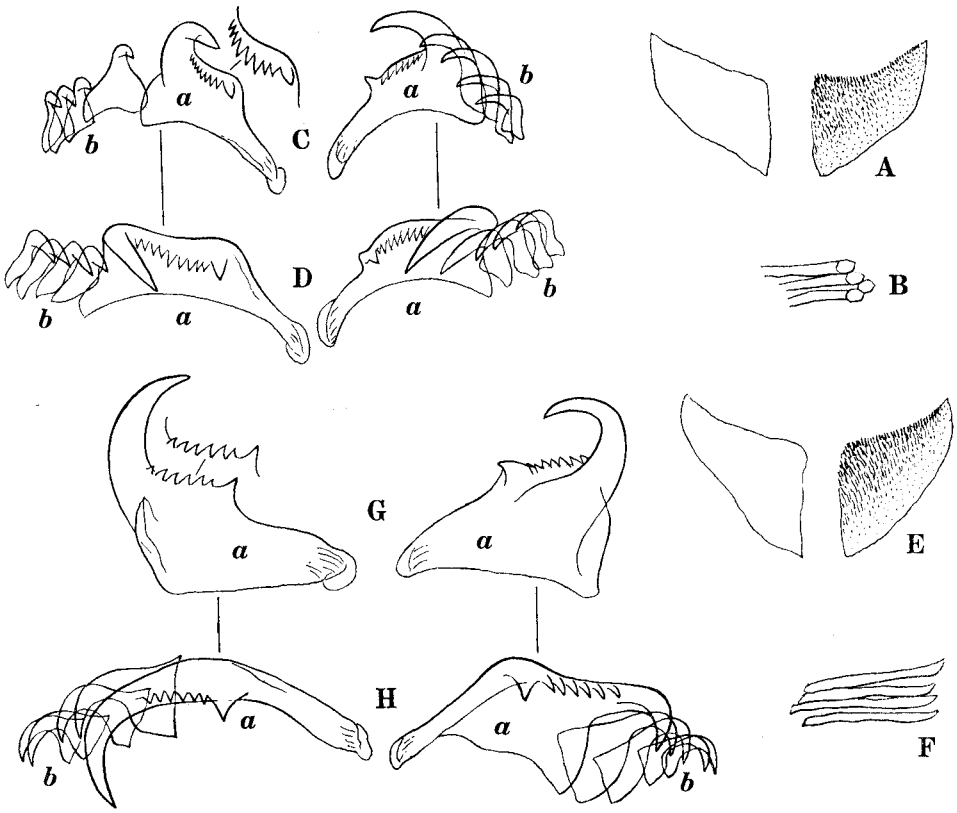

Fig. 6. *Gastropteron bicornutum* n. sp. A–D, Paratype No. 4; E–H, Paratype No. 7.
A—Paired jaw-plates, (×55); B—Elements of the jaw-plate, (×270); C—A row of lateral teeth in the distal end of the radular ribbon, (×65); D—A row of lateral teeth in the proximal end of the radular ribbon, (×65); E—Paired jaw-plates, (×35); F—Elements of the jaw-plate, (×130); G—A row of lateral teeth in the distal end of the radular ribbon, (×65); H—A row of lateral teeth in the proximal end, (×65). *a*···first lateral, *b*···marginals.

of ADAMS' species from its type locality is most keenly expected for the final arrangement of the species of *Gastropteron*.

Another specimen of this new species was collected by Mr. A. OUCHI from off Iwahune, Niigata Prefecture, on the Japan Sea coast of Honsyû Island, 26 m, on July 30, 1958, and examined by the first author.

2. *Gastropteron fuscum* n. sp.

(Japanese name : *Ayukawa-umikotyô*)

(Text-figs. 7, A–C, 8 ; Pl. XXV, fig. 10)

Type : Collected from the shore of Ayukawa, Etizen coast (Japan Sea side of Honsyû Island), 2 m, on August 8, 1964.

A living animal, freshly brought from the sea, was observed in a small vessel. Under such a condition it moves about very actively ; it crawls on the vessel wall or stays there still for a while, but often it goes voluntarily into a flapping flight in the water. The shape of the various body parts is liable to change according to different actions of the animal (Text-fig. 7, C). The total length of the animal from head to tail tip in the fully extended state measures approximately 4 mm (Text-fig. 7, A) ; the entire body is very narrow and with a long tapering tail. The head region does not extend far beyond the front level of parapodia and the cephalic shield assumes an elongated rectangular outline, broadest in front and gradually narrowed behind to form a funnel which is kept mostly more or less raised up while alive. This funnel is sustained by a dorso-median crest, which attains to the distal end of the funnel. The paired black eyes are seen through at about the middle of the cephalic shield. The dorsal hump takes usually an elongated oval appearance, and its general integument is smooth. Near the rear and slightly to the right of the median line of the dorsal hump there is found a long horn-like protuberance tapering to the tip. Evidently this protuberance stands widely apart from the posterior extremity of the free mantle margin, and hence it cannot be identified with the mantle flagellum. The parapodial lobes are capable of free expansion in the living state. The foot is flat on the sole, and it forms posteriorly a long tail as noted before.

The type preserved in alcohol and contracted to about 3.5 mm long was examined anatomically (Text-fig. 8, A–C ; Pl. XXV, fig. 10). The animal is presumed to be fully matured as there is a distinct formation of seminal groove (*S.g.*). From the male genital orifice is seen protruded out a curved penis (*P.*) of a remarkable size. The free mantle margin (*M.*) is very short and confined to about the right anterior part of the dorsal hump. The ctenidium (*G.*) remains rudimentary ; it is merely a tongue-shaped prominence of a 320 μ length and marked indistinctly with three minute folds near the tip. Behind the ctenidium lies an anal papilla. The black pigmentation of the nephridial aperture is obscured. The hermaphrodite genital orifice opens immediately below the anterior base of the ctenidium. The horn-like protuberance (*Kn.*) of the dorsal hump came to be greatly contracted, and now it takes a shape of a blunt knob. A part of the intestinal loop is visible through the

integument in the right anterior part of the hump. The shell could not be detected by any superficial examination. On the underside of the tail, there is an opening of the pedal gland on the median line, and a longitudinal groove leads from the pore to the tail tip. The mouth part was opened, but it ended in failure to analyze the jaws and radula in detail. Only it may be suggested that the type of the radular teeth is of *Gastropteron*.

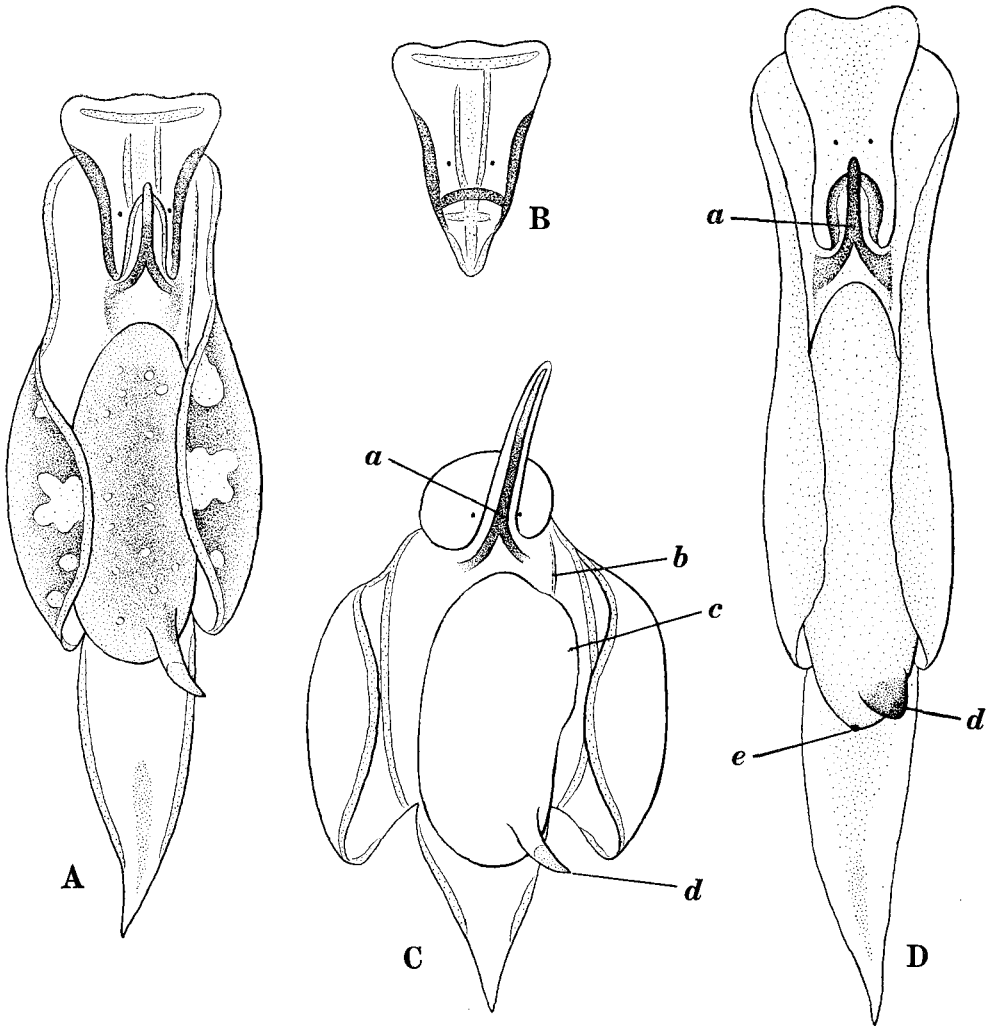

Fig. 7. A–C, *Gastropteron fuscum* n. sp. A—Living animal in active creeping, total length 4 mm; B—Outline of the cephalic shield; C—Living animal in the resting position, colouring partially omitted.
D, *Gastropteron flavum* T. & B. in active creeping, total length 4 mm.
a···dorso-median crest, *b*···seminal groove, *c*···free mantle margin, *d*···right posterior protuberance of dorsal hump, *e*···reddish purple spot.

The colouration of the type in life is extremely complicated and graceful (Text-fig. 7, A–C). The dorsal hump is deep chocolate brown spotted sparcely with white. The lower surface of each parapodium is also deep chocolate brown with a few, bold, irregular markings of white towards the free margin. The horn-like protuberance of the dorsal hump is tinted with vermilion distally. There is a narrow vermilion band along the entire length of the parapodial margin and on the border line between each paradium and foot. The tail is also edged with vermilion. On the cephalic shield, the presence of a transverse vermilion band running parallel to the anterior edge is the first to be noted. Then follow a pair of longitudinal bands of the same colour which extend from the level of the transverse colour band to near the

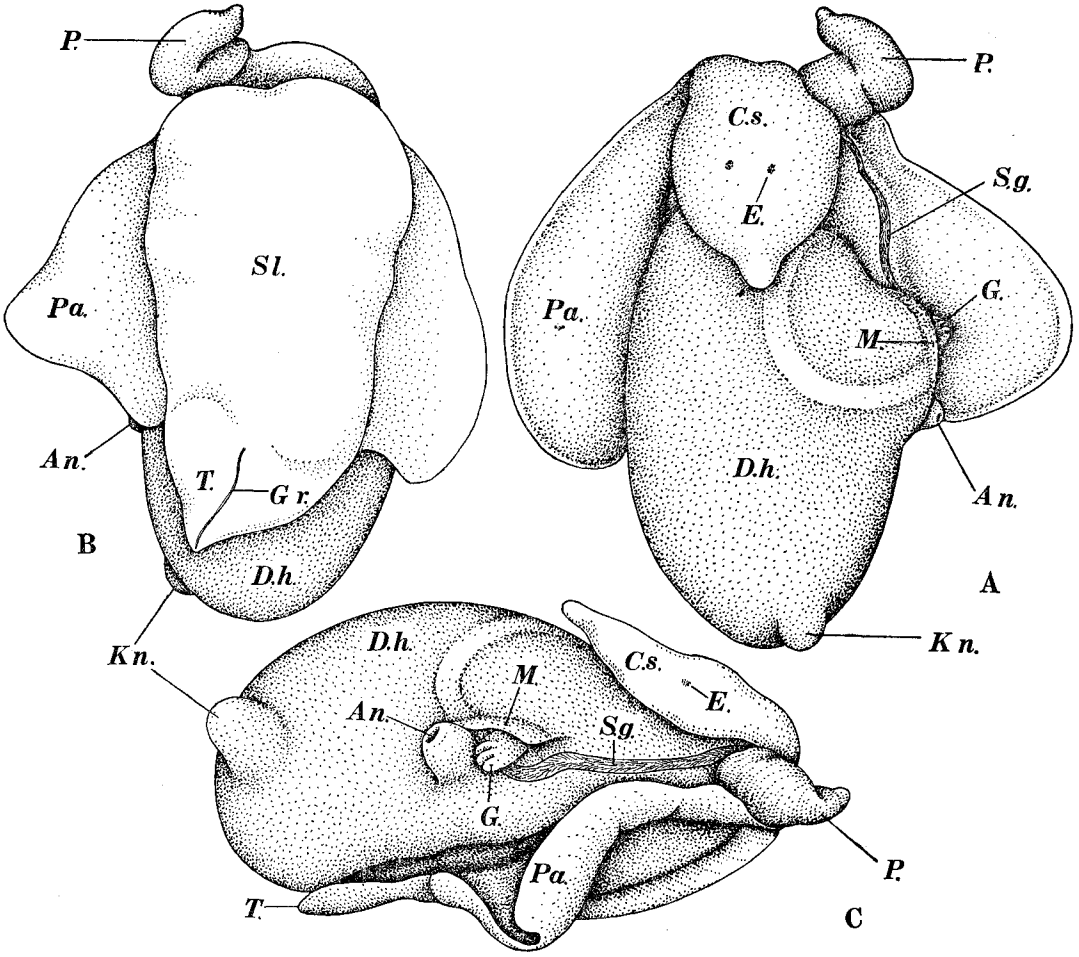

Fig. 8. *Gastropteron fuscum* n. sp. Preserved type, ×50. A—Dorsal side; B—Ventral side; C—Right side.

tip of the funnel converging distally and holding a narrow streak of snow white in between. The lateral edges of the shield are stained with deep chocolate brown. The free margin of the funnel is vermilion. The dorso-median crest is vermilion-tinted at the distal and chocolate brown at the proximal. The rest of the body including the sole is translucent and whitish in ground colour. On the underside of the tail there is a snow white streak on the median line which indicates exactly the position of the pedal gland. All these colours are faded out in alcohol, and the whole body is turned to a uniform grayish yellow.

Remarks: As stated above, the live animal is very distinctive in the genus *Gastropteron* in colours, and in the possession of a horn-like protuberance near the rear end of the dorsal hump slightly to the right. A new species is hence established, and it is named *fuscum* after the dominating colour of chocolate brown on the dorsal hump and the lower surface of the parapodial lobes.

This is a small-sized species very closely related to *G. flavum* T. & B. In both species the free mantle margin is short, the ctenidium is reduced in size, and there is a single protuberance of the dorsal hump. Actually this protuberance is horn-like in *fuscum* and blunt and knob-like (or better mammiform) in *flavum*. And dissimilarity of fresh body colour in the two species is very remarkable. In the case of studying preserved, contracted and discoloured specimens, however, such points of distinction between these two species are unavailable.

3. *Gastropteron flavum* TOKIOKA & BABA

(Text-fig. 7, D)

Material: Collected from the shore of Ayukawa on the Etizen coast of Honsyû Island facing the Sea of Japan, 2 m, on August 7, 1964. Found resting on algae.

A live specimen freshly taken from the sea was observed as in the preceding case. It is very small, and seemingly immatured. The general body appearance of the animal in an actively creeping state is represented in Text-fig. 7, D. Total length (from head to tail tip) measures 4 mm. The cephalic shield is elongated rectangular, and forms posteriorly a funnel rising up markedly. The dorso-median crest reaches the distal end of the funnel. The dorsal hump is elongated oval in outline. The knob-like protuberance near the right posterior corner of the hump is bunt at tip, and better be described as mammiform in the fresh state. Usually the parapodial lobes turn up over the dorsal hump. The tail is long and narrowed towards the tip. The sole is flat and well defined, although the animal is capable of swimming. The seminal groove is not yet developed. The free mantle margin is short. The ctenidium is small and seemingly simple with less than two

papillae on the surface. The live animal is of a general colouration of lemon yellow and dotted finely with deeper yellow. In a marked contrast to this colouration, there is an attractive colouring of reddish purple, instead of ivory black on the specimens from Sagami Bay, on the posterior margin of the funnel, on the dorso-median crest, and on the knob-like protuberance of the dorsal hump. In the present specimen, an additional reddish purple spot is found on the rounded rear end of the dorsal hump on the submedian line. The black pigmentation of the eyes and nephridial aperture is seen through the translucent integument. The position of the pedal gland on the tail is marked by deeper lemon yellow. In alcohol, the lemon yellow pigmentation of the body was quickly faded and the reddish purple pigment turned pinkish.

General Remarks on the Family Gastropteridae

The general body form of *Gastropteron* in an actively creeping position is elongated cylindrical with paired parapodia turning up over the back as in *Philine* and *Doridium*, and with the tail produced and tapering; the last feature is unique to *Gastropteron*. The cephalic shield forms posteriorly a funnel embracing the dorso-median crest and usually standing up markedly when alive. The embryonal shell wholly covered by the mantle is sometimes very difficult to be detected. The free mantle margin is short or greatly extended backward. In the typical species, *G. rubrum*, a flagellum is formed as the posterior extension of the free mantle margin, though this is quite missing in some others. The dorsal hump is entirely smooth (*G. pacificum*, *G. japonicum*) or studded on the posterior half with accessory protuberances greatly variable in shape and number according to species. The ctenidium is fairly developed in the typical species, but it tends towards reduction especially in smaller forms such as *G. flavum*. There is a thin pedal gland on the sagittal plane of the sole near the proximal portion of the tail, and frequently a longitudinal groove of different length may be found behind the gland pore. In the resting or contracted state, a considerable modification of appearance will take place in respective parts of the body. The expanded parapodia may serve for a flight in the water.

The living animals are coloured markedly and differently according to species. The eyes are usually discerned as a pair of black pigmented spots at the level of the middle of the cephalic shield. The nephridial aperture may be marked with dark pigmentation.

The paired jaw-plates are as a rule formed of rodlets, but they may be quite rudimentary in some species. The radular formula is 4–6.1.0.1.4–6 in *Gastropteron* and 9–12.1.0.1.9–12 in *Sagaminopteron*. The shape of the radular teeth of *Gastropteron* is closely allied to that of *Cylichna* (see LEMCHE, 1956, Pl. 41,

figs. 345–349), except for the entire missing of the rachidian teeth in the former. In both genera the first lateral is of the philinid type and minutely denticulated along the inner edge, while in *Sagaminopteron* the first lateral is provided with prominent cusps in place of minute denticles and the marginals are more numerous.

According to TAYLOR and SOHL (1962), the Gastropteridae is classified within the Philinoidea. In the external aspects the Gastropteridae relates most intimately to the Philinidae and Doridiidae, and it appears to be plausible that the former is more highly specialized than the latters in acquiring the high ability of swimming as well as in reducing the internal shell and shortening the visceral loop, though as to the radula the Philinidae is deviated from the stock towards the omission of the marginals and the Doridiidae to the complete obliteration of the whole organ. The relative situation of the Gastropteridae in the order Cephalaspidea is here shown in a simplified system laying stress on the evolution of the shell and nervous system. For phylogenetic discussions, see GUIART, 1910 (p. 201), and BOETTGER, 1955 (pp. 265–266, text-fig. 1). The Runcinidae is excluded here as it is reserved for further considerations (see GHISELIN, 1963, p. 396; BURN, 1963, p. 21).

Class Gastropoda

Subclass Opisthobranchia

Order Cephalaspidea

A cephalic shield accompanied with paired HANCOCK's organs. Paired parapodia. An external seminal groove. Penis provided with a prostate. Nerve ring prepharyngeal, with a long, mostly euthyneurous, visceral loop. A convoluted external or internal shell. Operculum usually disappeared.

Superfamily Philinoidea

Shell external to internal.

Family Scaphanderidae (*Scaphander*, *Cylichna*, etc.)
Primitive stock. Shell external, solid to fragile. Visceral loop long. Three gizzard-plates. Radula 1.1.1, or ∞.1.1.1.∞, several marginals. Jaws absent, or formed of fine rods when present.

Family Philinidae (*Philine*, etc.)
Advanced. Shell internal, convoluted, fragile. Visceral loop long. Three gizzard-plates. Radula 1.0.1, or ∞.1.0.1.∞. Jaws absent.

Family Doridiidae (*Doridium*, *Chelidonura*, etc.)
Advanced. Shell internal, convoluted, but extremely flattened and fragile. Visceral loop long. No gizzard-plates. Jaws and radula missing.

Family Gastropteridae (*Gastropteron, Sagaminopteron*)

Most advanced. Shell internal, almost vestigial. Visceral loop shortened. No gizzard-plates. Radula ∞.1.0.1.∞, marginals several to moderate. Jaws formed of fine rods.

ABBREVIATIONS

An. ...Anus
Cs. ...Cephalic shield
D.h. ...Dorsal hump
d.p. ...Dorsal protuberance
E. ...Eye
G. ...Ctenidium
Gr. ...Longitudinal groove
Kn. ...Knob-like protuberance
M. ...Free mantle margin
m.g.o....Male genital orifice
Mo. ...Mouth
Ne. ...Nephridial aperture
Pa. ...Parapodium
P. ...Penis
P.g. ...Pedal gland
S.g. ...Seminal groove
Sl. ...Sole
T. ...Tail
v.p. ...Ventral protuberance

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EXPLANATION OF PLATE XXV

Figs. 1–2. *Gastropteron bicornutum* n. sp., preserved holotype. Dorsal (1) and ventral (2) sides. (×2.3)

Figs. 3–4. *Gastropteron bicornutum* n. sp., preserved paratype No. 1. Dorsal (3) and ventral (4) sides. (×3)

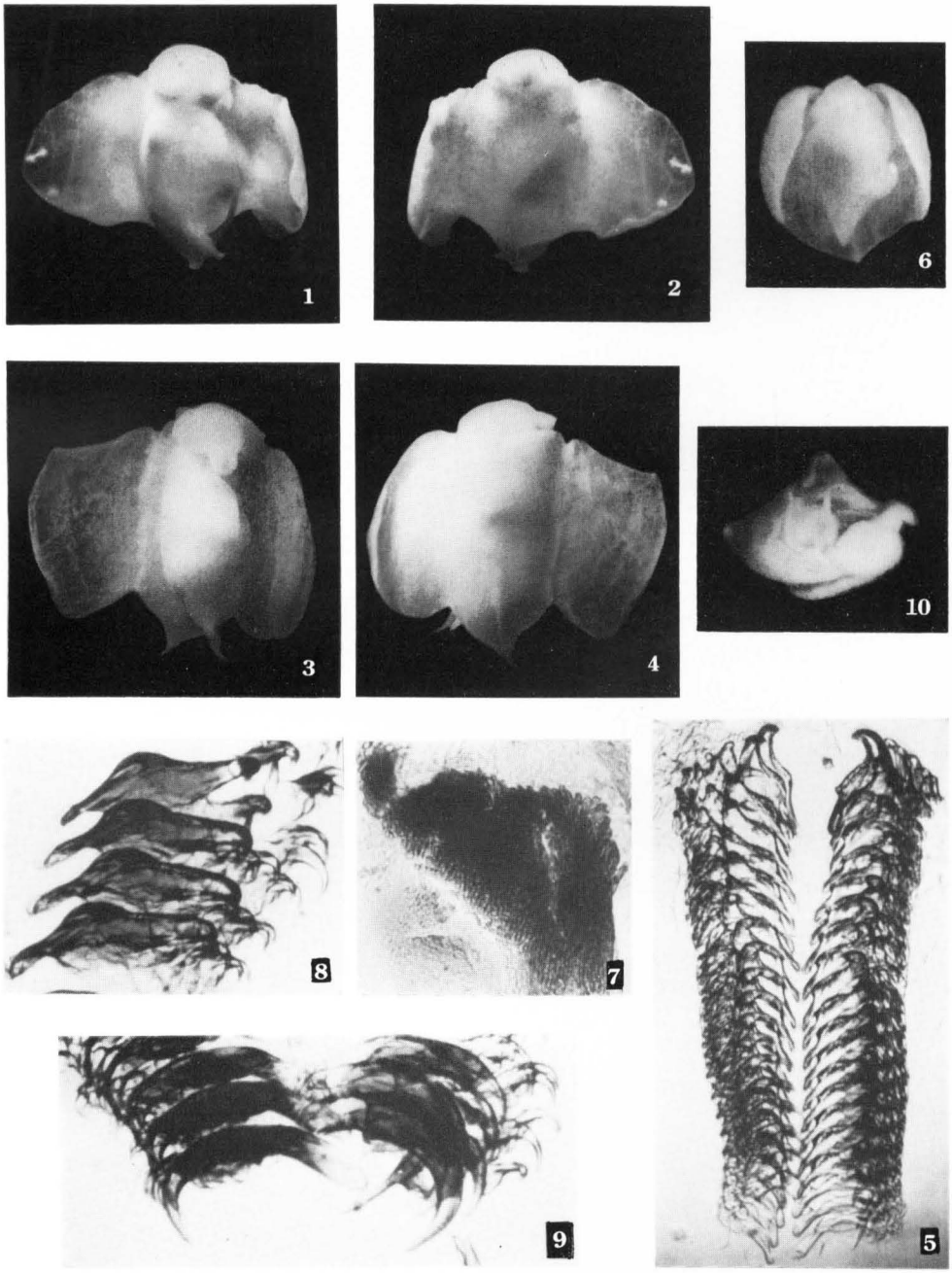
Fig. 5. *Gastropteron bicornutum* n. sp., paratype No. 4. Entire radular ribbon from above. (×37)

Fig. 6. *Gastropteron bicornutum* n. sp., preserved paratype No. 5. Dorsal side. (×6.5)

Figs. 7–9. *Gastropteron bicornutum* n. sp., paratype No. 7.

7. A jaw-plate. (×65)
8. Right half-row of lateral teeth in the distal end of the radular ribbon. (×55)
9. A row of lateral teeth in the proximal end of the radular ribbon. (×55)

Fig. 10. *Gastropteron fuscum* n. sp., preserved type. Right side. (×10)



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