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MATTHIAS STEHMANN

RE-ASSIGNMENT OF *RAJA ATRA* MÜLLER & HENLE, 1841 TO THE SYNONYMY OF *RAJA RADULA* DELAROCHE, 1809 (*Pisces, Rajiformes, Rajidae*)

SUMMARY

CAPAPÉ & DESOUTTER (1979) re-investigated the two syntypes of the Mediterranean *Raja atra* Müller & Henle, 1841 and correctly discovered that each belongs to a different species. On the basis of the larger of the two syntypes — the smaller one was a *Raja undulata* — they re-erected the taxon *Raja atra*, whereas the present investigation of this same specimen shows that it exactly corresponds with *Raja radula* Delaroche, 1809. The majority of past authors had also synonymized MÜLLER & HENLE'S species with the latter.

RIASSUNTO

Riassegnazione di Raja atra *Müller e Henle, 1841, alla sinonimia di* Raja radula *Delaroche, 1809.* — I due sintipi di *Raja atra* Müller e Henle, 1841, conservati uno al Museo di Parigi (MNHN n. 1588) e l'altro al Museo di Berlino (ZMHU n. 4603) furono ristudiati da Capapé e Desoutter (1979) che li scoprirono appartenere a due specie diverse. Il più piccolo (quello conservato a Parigi), una femmina giovane, fu correttamente da questi autori attribuito alla specie *Raja undulata* Lacépède, 1802. L'altro, una femmina di circa 575 mm di lunghezza, era, secondo Capapé e Desoutter, diverso sia da *R. undulata* che da *R. radula* Delaroche, 1809. Fu, quindi, da essi riconfermata la specie *R. atra* Müller e Henle, 1841 e il sintipo di Berlino divenne olotipo ed unico esemplare.

In realtà, sulla base di accurate comparazioni non vi è nessuna evidenza che il sintipo di Berlino differisca significativamente da *R. radula.*

Essendo, quindi, i due sintipi di *R. atra* appartenenti uno (quello di Parigi) a *R. undulata* e l'altro (quello di Berlino) a *R. radula*, viene ristabilita la sinonimia di *Raja atra* con *R. radula.*

INTRODUCTION

CAPAPÉ & DESOUTTER (1979) published a brief contribution on the validity of *Raja atra* Müller & Henle, 1841 after having investigated both syntypes. They stated correctly that each of them represents a different species, and thus consequently had to prove the validity of this species taxon.

The syntype in the Paris Museum (MNHN No. 1588), a juvenile female of 224 mm total length, proved to be a faded specimen of *Raja undulata* Lacépède, 1802, the other, in the Berlin Museum (ZMHU No. 4603, wrongly noted as No. 4063 throughout the paper by CAPAPÉ & DESOUTTER), a female of about 575 mm total length, was thought by these authors to be obviously distinct from *R. undulata* and *R. radula* Delaroche, 1809, as well as other congeners. Consequently, CAPAPÉ & DESOUTTER re-erected the taxon *Raja atra* Müller & Henle, 1841 on the basis of the Berlin syntype, now as holotype and only specimen.

The fact is that MÜLLER & HENLE's (1841: 134, pl. 46) original description is brief, but is not as poor as cited by CAPAPÉ & DESOUTTER (1979: 72). The translation from German is as follows: « Disc - the snout, eyelids, teeth, shape and squamation of the disc as in *R. radula*. The juvenile specimen (author's remark: = *R. undulata*) is smooth, but possesses larger thorns on the ridges of the eyes, back, and tail and a thorn on the shoulder girdle. Colour – colour of upper side uniformly black, lower side white except for margins of pectorals, which are likewise blackish-brown. Lower surface of tail with several dark spots ».

The original description is accompanied by an excellent large-scale illustration of the dorsal side of the Berlin syntype. However, this illustration was not at all mentioned, nor was taken into consideration by CAPAPÉ & DESOUTTER.

Furthermore, these authors presented a redescription of the *R. atra* holotype, which is not really in accordance with todays standards of a morphological rajid description, as is shown especially by the complete lack of actual morphometrics. Only a few proportional relations are given, several of which are calculated with regard to the total length and the length of the disc. However, neither the actual total length nor that of the disc are stated anywhere in the paper, as are neither the remaining measurements. Furthermore, although they mention (p. 73) that the rostrum is largely destroyed, they nevertheless give relations calculated on the total length and disc length and also present in their fig. 1A a drawing of the specimen in dorsal view with a reconstructed snout. Additionally, their description

of the shape of the snout and disc (p. 73) does not correspond with their fig. 1A as far as the pectoral apices are concerned, but agrees perfectly with MÜLLER & HENLE's original illustration. This shows a short and bluntly angled snout, in contrast to the somewhat extended and pointed snout described and figured in the reconstruction by CAPAPÉ & DESOUTTER.

Such contradictions and the fragmentary description, as well as the incomplete comparison with congeners, urged the present investigation while the rajid contributions to FNAM were being prepared with D. L. BÜRKEL.

DESCRIPTION

I. - *Raja atra* Müller & Henle, 1841 (figs 1-6)
Holotype ZMHU No. 4603, a female of about 575 mm TL (snout destroyed).

For measurements and meristics see table I.
Fig. 1 is a reproduction of MÜLLER & HENLE's original illustration,

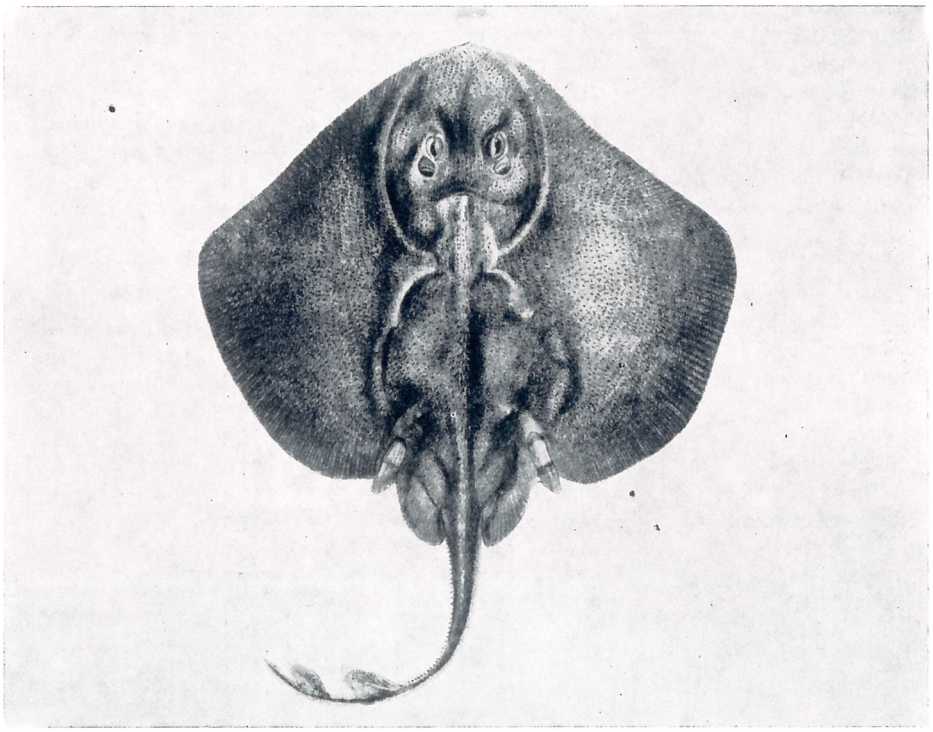

Fig. 1. — *Raja atra.* Original illustration of MÜLLER & HENLE in half size.

Table I

Proportional dimensions in per cent of disc width, meristics, and anatomical measurements of the Raja atra *holotype and two specimens of* Raja radula, *and literature data for* R. radula.

	♀ *Raja atra* ZMHU 4603		♀ *Raja radula* ISH 4013a/71		♂ *Raja radula* ISH 4013b/71		♀ *Raja radula* after CLARK (1926)	
	mm	%	mm	%	mm	%	mm	%
Total length	ca. 575.0	—	450.0	—	438.0	—	347.0	—
disc, width	365.0	100.0	293.0	100.0	264.0	100.0	221.0	100.0
length	?	—	237.0	80.9	227.0	86.0	178.0	80.5
preorbital snout length	?	—	53.0	18.1	46.0	17.4	41.0	18.6
orbit, horizontal diameter	22.5	6.2	18.2	6.2	17.7	6.7	13.0	5.9
interorbital width	24.7	6.8	19.6	6.7	19.3	7.3	14.0	6.3
spiraculum	15.5	4.2	13.0	4.4	13.0	4.9		
interspiracular width	37.7	10.3	32.0	10.9	28.5	10.8		
orbit + spiracle	28.4	7.8	22.8	7.8	22.0	8.3	17.0	7.7
D1, vertical height	18.7	5.1	11.7	4.0	13.2	5.0		
base length	30.5	8.4	25.7	8.8	25.0	9.5		
D2, vertical height	14.3	3.9	10.5	3.6	12.9	4.9		
base length	26.3	7.2	24.0	8.2	26.0	9.8		
postdorsal tail length	21.0	5.8	17.6	6.0	19.7	7.5		
distance D1 - D2	13.7	3.8	10.5	3.6	5.0	1.9		
C, base length	21.0	5.8	17.6	6.0	19.7	7.5		
tail, height at base	12.3	3.4	9.0	3.1	8.4	3.2		
width at base	16.2	4.4	15.7	5.4	15.0	5.7		
height at D1	6.0	1.6	6.0	2.0	4.6	1.7		
width at D1	7.0	1.9	9.5	3.2	9.0	3.4		
length lateral tail folds	224.0	61.4	183.0	62.5	167.0	63.3		
preoral snout length	?	—	47.5	16.2	40.9	15.5	43.0	19.5
prenasal snout length	?	—	36.7	12.5	30.8	11.7	30.0	13.6
head length, ventrally	?	—	118.6	40.5	107.2	40.6		
mouth width	48.0	13.2	37.0	12.6	34.8	13.2	29.0	13.1
internasal width	?	—	34.8	11.9	32.2	12.2	25.5	11.5
nasal curtain, length	ca. 26.0	ca. 7.1	23.6	8.1	24.0	9.1		
width of each lobe	ca. 10.5	ca. 2.9	9.3	3.2	11.4	4.3		
distance between lobes	ca. 34.0	ca. 9.3	19.8	6.8	17.5	6.6		
length gill slit, 1st	10.6	2.9	9.2	3.1	8.7	3.3		
3rd	12.0	3.3	9.7	3.3	8.7	3.3		
5th	8.0	2.2	6.3	2.2	6.0	2.3		
interbranchial width, 1st′	87.0	23.8	64.8	22.1	55.4	21.0		
5th′	47.0	12.9	32.6	11.1	30.5	11.6		
V, length anterior lobe	59.0	16.2	44.3	15.1	48.9	18.5		

— continued —

Table I *continued*

	♀ *Raja atra* ZMHU 4603		♀ *Raja radula* ISH 4013a/71		♂ *Raja radula* ISH 4013b/71		♀ *Raja radula* after CLARK (1926)	
	mm	%	mm	%	mm	%	mm	%
clasper, postanus length	—	—	—	—	123.0	46.6		
snout - middle of anus	?	—	211.8	72.3	195.0	73.9	154.7	70.0
middle of anus - D1	195.0	53.4	160.0	54.6	165.6	62.7		
- D2	240.0	65.8	196.8	67.2	195.4	74.0		
- tip of tail	289.5	79.3	235.2	80.3	238.5	90.3	191.2	86.5
max. disc width at % of disc length	?	—	135.0	57.0	134.0	59.0		
angle of snout	110°		140°		135°			
tooth rows, upper/lower jaw	37/36		39/38		36/31		40/—	
pseudobranchial folds, left/right	10/12		12/14		12/13			
Vtr / Vprd	26/52		29/49		26/51			
pectoral radials, left/right	79/81		83/83		82/81			
neurocranium, TL	?		87.0		79.0			
max. width	72.7		55.1		52.9			
min. dorsal interorbital width	23.4		18.0		17.7			
max. width regio otica	36.9		34.0		28.8			
max. width at jugular arches	40.1		33.5		27.0			
length of rostrum	?		36.0		31.7			
width rostral base	19.9		16.5		14.5			
post. angle nasal capsules	63°		67.5°		68°			
pelvic girdle, max. width	65.3		51.0		42.0			
pectoral girdle, max. width	92.5		65.5		53.7			

fig. 2 being a photograph of the same specimen in its present-day state. The specimen still agrees with the original illustration except for the lacking central part of the snout as shown in fig. 3. Dr. H. J. PAEPKE (pers. comm. 1980), the fish curator of the ZMHU, commented on this: « the lack of the tip of the snout originates possibly already from J. Müller, who was a great anatomist ».

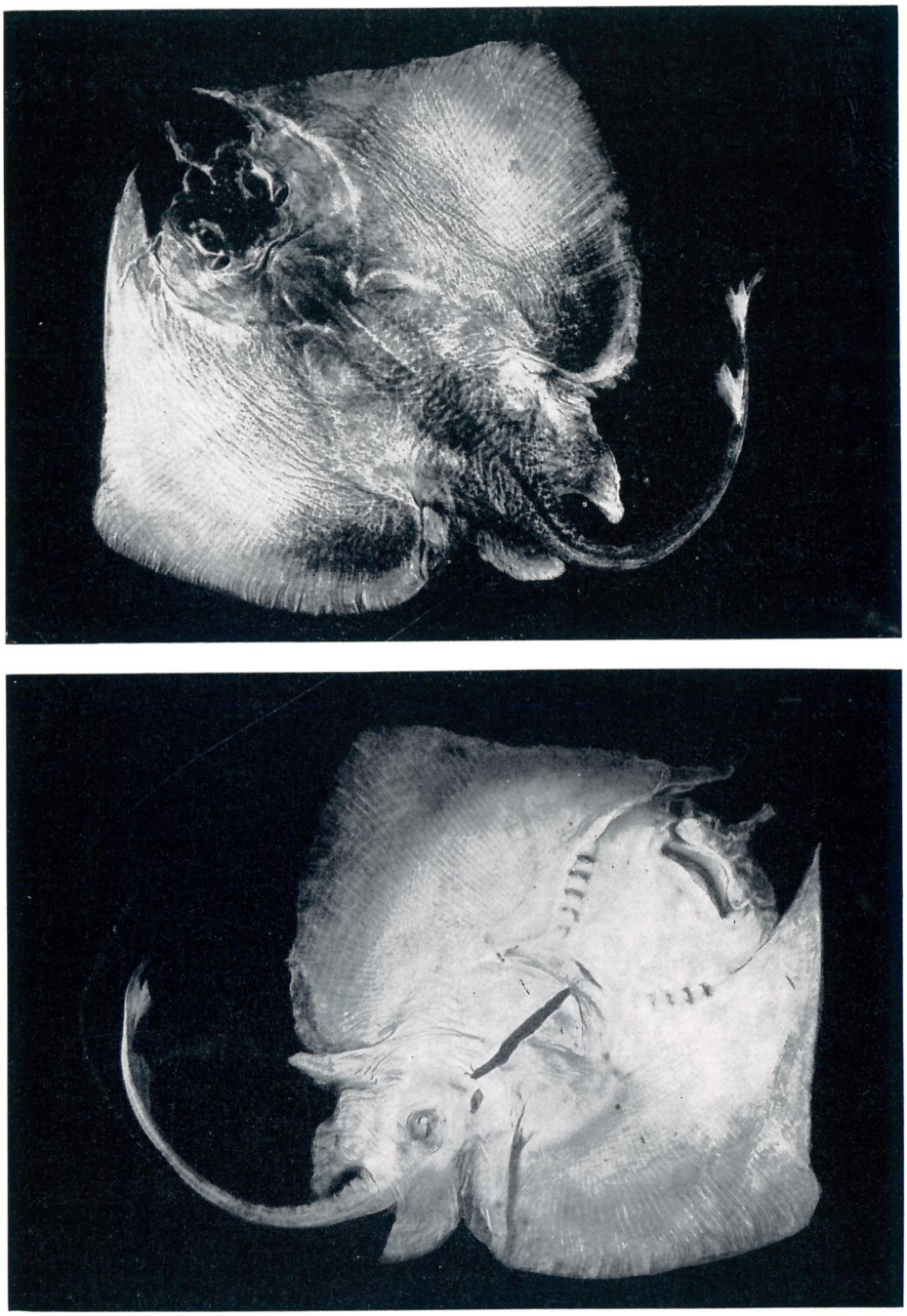

Fig. 2. — *Raja atra* Müller & Henle, 1841. Holotype ♀ ZMHU No. 4603, dorsal and ventral view, reduced to 68,4% of original size.

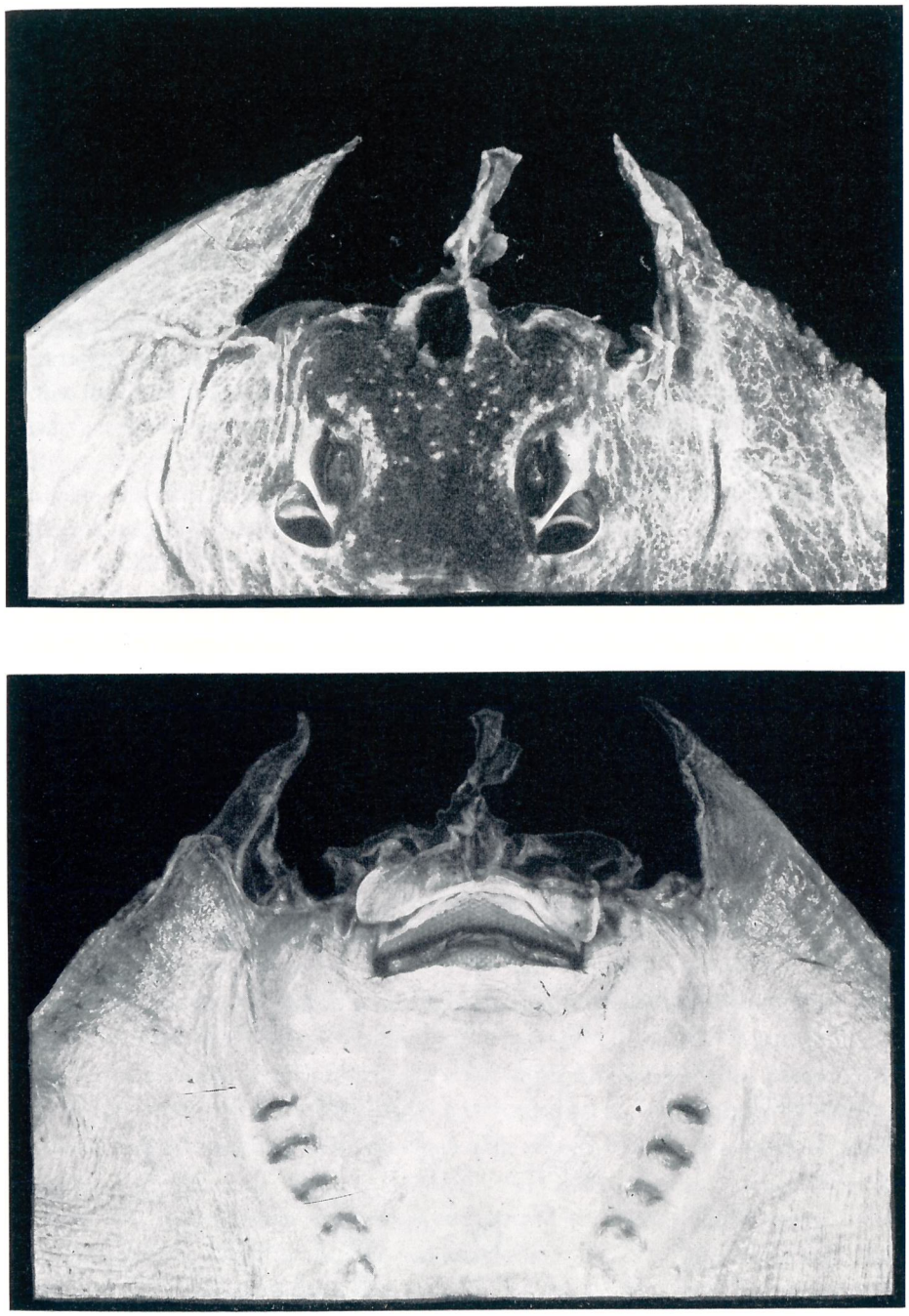

Fig. 3. — *Raja atra* Müller & Henle, 1841. Holotype ♀ ZMHU No. 4603, head in dorsal and ventral view, as fig. 2.

a) Morphology

Disc evenly rhombic or subquadratic and relatively broad. Axis of greatest disc width at level of pectoral girdle. Anterior margins of disc almost straight, posterior margins slightly convex, pectoral apices bluntly angled. Pelvics normal, the anterior lobes relatively short and massive, the posterior ones somewhat extended and with convex outer margins and narrowly rounded tips. Tail about as long as the body and moderately slender, its cross-section almost semicircular to subquadrangular rather than depressed. Distinct lateral tail folds from level of pelvic tips not to the very end of the tail. Dorsal fins almost equal in size and shape, separated by an interspace of about half the basal length of D1. Caudal fin a low fold with convex margin from end of D2 on, and about a quarter as high as the latter.

Snout short, forming an angle of about 110° according to the original illustration, its tip not projecting and hence very obtuse. Orbits and spiracles relatively large, the latter with 10-12 pseudobranchial folds. Mouth slightly curved to almost straight, with 37 tooth-rows in upper and 36 in lower jaw, the teeth in pavement arrangement. Individual teeth broadly hexagonal with a transverse blunt ridge across their entire width (fig. 4a). This ridge distinct in teeth of the median third of the upper jaw, but becoming less so towards outer rows, the last 4-5 of which being made up of flattened teeth. The ridge generally less distinct in teeth of the lower jaw in its median third, in the outer thirds completely absent. Outer margins of nasal curtain weakly undulated to almost straight, with rear apices angular, the straight transverse rear margins being set with several short distinct lobelets.

No comparison is possible with regard to the proportional relations given by CAPAPÉ & DESOUTTER (1979: 73), as they based nearly all of these on the theoretical total length and length of the snout in contrast

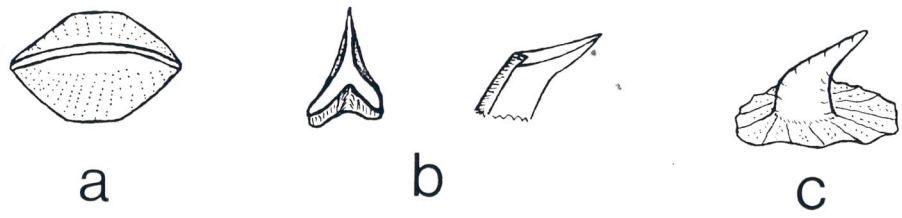

Fig. 4. — *Raja atra* Müller & Henle, 1841. Holotype ♀ ZMHU No. 4603. (a) Tooth from middle of upper jaw (13 × nat. size), (b) spinule from upper pectoral center in top and lateral view (23 × nat. size), (c) thorn of median row on trunk (7 × nat. size).

to proportions traditionally calculated on the basis of the disc width, should a specimen have a damaged snout or tail tip. Actual measurements are not given by CAPAPÉ & DESOUTTER (1979), but can here be found in table 1.

No comment on the outline of the ventral ampullae of Lorenzini is here given as has earlier been shown (STEHMANN, 1970) through the investigation of large series of specimens that this character is hardly species specific.

Squamation – upper side of disc completely set with coarse spinules (figs 2, 3, 4b), only a moderately broad stripe along each posterior pectoral margin being smooth. Spinules coarser and closer set on nape/shoulder area and extremely so in interorbital space and on nasal capsules where they form a compact scale covering. Inner parts of eyes as well as dorsal and caudal fins set with fine spinules. Pectoral axils and anterior pelvic lobes smooth. Posterior pelvic lobe centrally with a band of spinules. Upper surface and sides of tail covered with closely set coarse spinules. The lower side of specimen not completely smooth as described by CAPAPÉ & DESOUTTER (1979: 73), but set in certain parts with three different types of spinules, all of which are distinct from the dorsal ones. The interbranchial space and a U-shaped band parallel to the rear edge of the pectoral girdle with a loose scattering of spinules, all of which have short and smooth tips. Also a small patch or strip of closely set spinules in, or immediately behind each gill slit of the first to fourth pairs, and in a distinct U-shaped band around the front edge and sides of the anus, these spinules having elongate and smooth tips. Furthermore, underside of tail more or less loosely set with spinules, which are, except for the smooth root of tail, more concentrated along the outer edges of the tail and in its median third. These spinules again different, in that they are not only extremely flat but also have a cardiform-conical tip, which is almost embedded in the tail surface.

Most thorns on upper side, with a few exceptions, very small. Only one preorbital thorn now present on the left side, but basal scars indicating that 2-3 may have been present on each side. No interorbital thorns. Only one right postorbital still present, but basal scars indicating a postorbital and an interspiracular thorn on each side. Two closely set median nuchal thorns, the rear one almost abraded. All these thorns rather indistinct among the very coarse and close set spinules. Two widely spaced small median thorns directly behind shoulder girdle. No suprascapular thorn and none on the scapulae, but in this region integument largely to completely abraded down to the cartilage. Median thorns on body and tail, after a distinct gap without thorns, continuous from about the posterior

third of trunk to about level of pelvic axils. These median thorns small (fig. 4c), about 19 in number in a very irregular line, with 6-7 of them to level of pectoral axils, at which position the single series abruptly changes (fig. 5) to a very irregular parallel row of thorns along the shallow, median, groove-like depression in the anterior third of the tail length. At the side of the two rows, several irregularly scattered additional thorns. Continuation of the median thorns rearward again after an abrupt change to four median thorns flanked by irregular smaller thorns, followed by a portion of two irregular parallel rows, between and alongside of which thornlets are scattered. Last third of tail length with scattered thornlets, a few small thorns on either left or right side, and two larger median thorns. Interdorsal space with irregular thornlets. Most spinules on sides of tail hook-like and very coarse. On right side 5, on left 9 additional variously widely spaced small hooked thorns present in the anterior half of tail length along lateral lower edges. The present arrangement of these thorns, although irregular, nevertheless does give the strong impression of an in-line arrangement, and thus indicates that this large adult female, at a smaller size, may have had a median row of thorns from the posterior

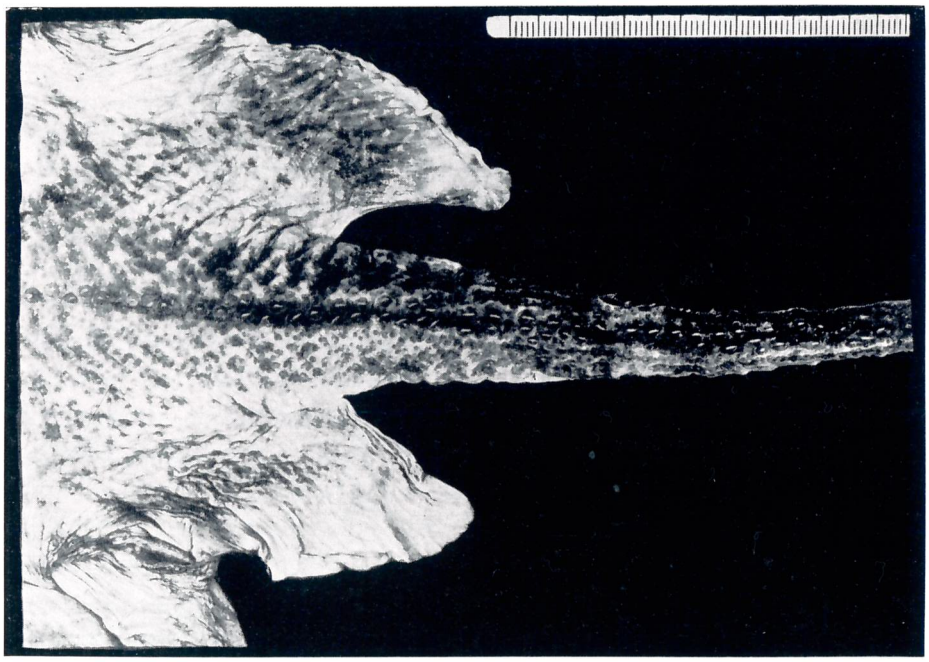

Fig. 5. — *Raja atra* Müller & Henle, 1841. Holotype ♀ ZMHU No. 4603, upper side of tail, as fig. 2.

half of the trunk to about the first dorsal, the row flanked by one or two irregular parallel rows of variously large thorns. With increasing age this median row was probably irregularly reduced, i.e. in certain parts entirely with parallel thorns persisting, while in other parts it and the parallel rows persisted, so that a clear arrangement on the tail is no longer shown.

Colour – the specimen which has been in alcohol presumable for more than 140 years, although in good condition, except for the damaged snout, is almost entirely discoloured and faded. Original more or less dark dorsal pigmentation as described by MÜLLER & HENLE is still visible as a distinct brown where spinules closest set, i.e. in interorbital space, on nape and shoulders, along trunk, on inner posterior parts of pectorals, centre of posterior pelvic lobes, and particularly on entire tail. Orbits, tips of anterior pelvic lobes, dorsals and caudal fin similarly brown. Lateral tail folds marbled brown and white. Remains of brown pigment also present at bases of individual spinules on pectorals, while integument in these areas pale white. Lower surface white. Margins of disc translucent and somewhat brownish, particularly so at outer and inner corners. Underside of tail with several pale brown spots in median third of tail length, and remains of brown pigment also in folds between anterior and posterior pelvic lobes.

Damage – snout area destroyed from level of nasal capsules forward. Base of rostral cartilage present, but deformed due to twisting and breaking of rostrum at about middle of anterior fontanelle. Radials still present over almost full forward length of pectorals.

b) Anatomy (based on radiographs)

Neurocranium (fig.6) – rostral cartilage badly damaged and almost lacking. Its length, if original illustration (fig. 1) is taken into consideration, certainly less than 50% of total length of skull, while CAPAPÉ & DESOUTTER (1979: 74) state « more than 50% of the total length of the cranium ». Width of rostral base 27.4% of greatest cranial width, which is 78.6% of maximum width of the pectoral girdle. *Regio orbito-temporalis* deeply concave, minimum dorsal width 32.2% of the greatest cranial width and 63.4% of the maximum width of the *regio otica*. This is short and massive, and 50.8% of the maximum cranial width. Jugular arches massive, laterally exceeding the contour of the *regio otica*, but rearward not quite as long as the occipital condyles. Nasal capsules broadly expanded, but generally angular rather than rounded, their almost straight posterior edge at an angle of 63° to the longitudinal axis of the skull, the anterior edges damaged. Postorbital processes very distinct, the pterotic ones less so (CAPAPÉ & DESOUTTER, 1979: 74, indicate in their description a doubled

postorbital process distinct from the jugular arches, as should be expected anyhow, although their fig. 1G is correctly explained). Anterior fontanelle damaged, but presumably more or less egg- to drop-shaped. Its posterior part nearly trapezoid — not rounded — with a slightly concave transverse rear edge behind the level of maximum cranial width. Both fontanelles

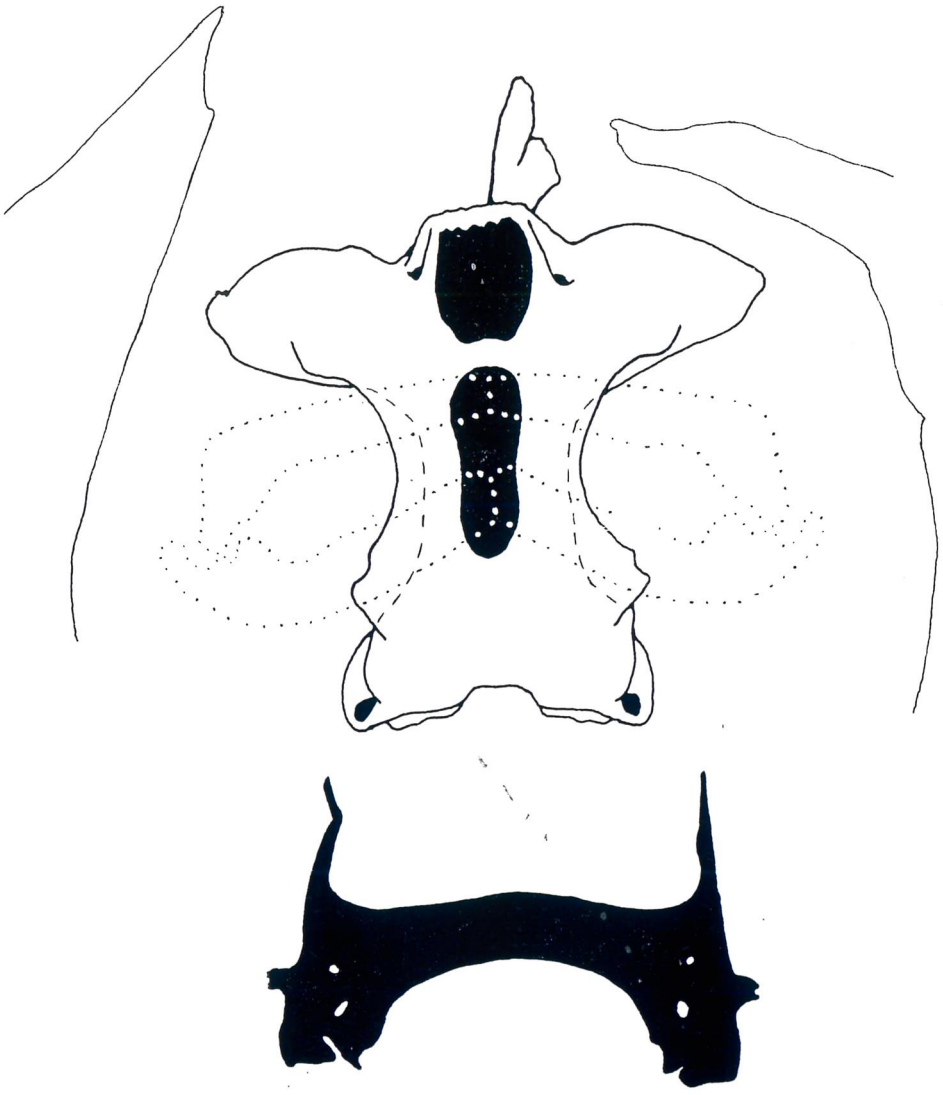

Fig. 6. — *Raja atra* Müller & Henle, 1841. Holotype ♀ ZMHU No. 4603. Neurocranium and pelvic girdle in natural size, somewhat schematized after radiograph.

well separated. The posterior one dumb-bell-shaped and rounded at both ends, its rear part somewhat narrower. Its rearward extension almost to level of the postorbital processes. CAPAPÉ & DESOUTTER (1979: 74, fig. 1G) surprisingly described a complete anterior fontanelle and give an almost correct description of the posterior one, although their illustration of the latter is distinctly different.

Pelvic girdle (fig. 6) – relatively small, with front edge slightly angled forward, and rear edge a deeply rounded arc. Prepubic processes long, slender and pointed. Both broken and deformed in the specimen. Left one with its slight inward curvature suggests that both may have done so. Length of these processes about 44% of the pelvic girdle width. Iliac processes short massive hooks. Two iliac foramina. Maximum width of pelvic girdle 70.6% of shoulder girdle and 89.8% of the greatest cranial width, the shoulder girdle 127.2% of the latter.

Vertebrae and pectoral rays – Vtr 26, Vprd 52, and 42 postdorsal vertebrae, i.e. a total count of 120. 79/81 pectoral radials. CAPAPÉ & DESOUTTER (1979: 76) counted a total of 142 vertebrae but specified only 26 as Vtr.

II. - *Raja radula* Delaroche, 1809 (figs 7-9).
Material: apart from accounts in the literature, a pair of adults from Sicily, ISH No. 4013a b/71.

For detailed measurements and meristics see table 1.

Since *R. radula*, for which modern complete descriptions are lacking, is a species which is often mistaken for others, particularly *Raja melitensis* Clark, 1926 and *Raja polystigma* Regan, 1923, it is not quite understood why CAPAPÉ & DESOUTTER restricted themselves to deal comparatively only with skeletal anatomies. Because of this, it is not possible to compare the external characters of the species concerned.

a) Morphology of the ISH specimens

Disc evenly rhombic or subquadratic, with greatest width at level of pectoral girdle. Anterior disc margins almost straight, even in male, and only convex towards snout tip. Posterior margins moderately convex, with outer corners bluntly angled. Anterior pelvic lobes short and massive, posterior ones rather extended with outer margins convex and tips narrowly rounded. The fully developed male claspers extending over about 2/3 of tail length. Tail slightly longer than body, rather solid and distinctly depressed over entire length. Distinct lateral tail folds from level of pelvic tips not to the very end of tail. Dorsal fins relatively large, almost equal in size

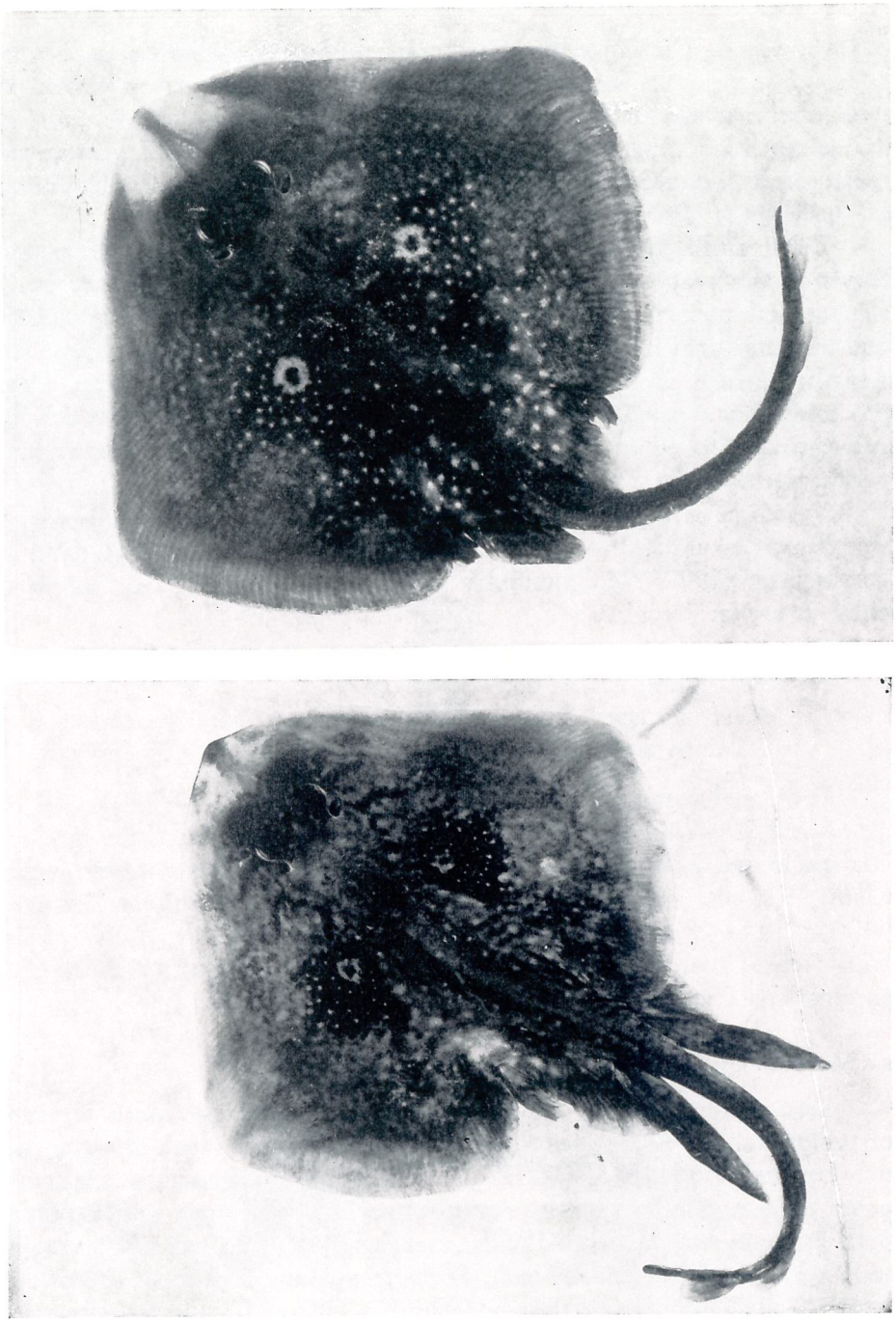

Fig. 7. — *Raja radula* Delaroche, 1809. Adult ♀ and ♂ ISH No. 4013a-b/71 in dorsal view, as fig. 2.

and shape, and with a clear interspace between them. Caudal fin a low fold arising from end of D2, about 1/4 to 1/3 as high as the latter, and reaching to end of tail. Snout very short and bluntly angled (135°-140°), its tip not pronounced. Orbits and spiracles large, the latter with 12-14 pseudobranchial folds. Mouth small, jaws slightly angled in the female, distinctly so in the male, with 39, resp. 36 tooth rows in upper and 38, resp. 31 in the lower jaw. Sexual dimorphism in shape and arrangement of teeth marked. Those of the female in pavement arrangement and exactly alike those of the *R. atra* holotype, with only the transverse tooth ridge less high and prominent. Those of the male in well separated parallel rows of pointed slender teeth medially, but triangular broadly conical ones in the outer quarters of the jaws. Nostrils surrounded by a delicate triangular flap with finely fringed posterior margins. Nasal curtain relatively long, with almost straight outer margins, angular apices, and distinct lobelets on narrow posterior margins. The isthmus between both lobes a narrow deep arc.

Squamation – the spinulation shows a sexual dimorphism as in many species of *Raja*. That of the female corresponds exactly in very detail with the *R. atra* holotype spinulation even in the dorsal and ventral distribution of spinules as well as in the different types of spinules particular to certain areas on the lower side (incl. spinules set almost in gill slits 1 to 4).

Dorsally the male is almost smooth on the pectoral centers and sides of the trunk, on the sides of the snout and orbits and along the posterior disc margins. The head, back of the trunk and the anterior disc margins are heavily spinulose (type of spinules as in the female), while a patch of sparse spinules is also found at the pectoral axil. There are a few scattered spinules centrally on the posterior pelvic lobe. Claspers smooth. Tail, dorsals and caudal fins densely prickled as in the female. Ventrally, pointed spinules densely set only in prenasal snout region to disc's margins, with a few such spinules also scattered on shoulder girdle, but none in gill slits or around the anus. Underside of tail all over loosely set with spinules of the same flattened, nearly imbedded type as in the female.

In general, all the thorns on the upper side are very small as in *R. atra*. The female specimen shows 5-7 thornlets on each side in preorbital, postorbital, and interspiracular position, while the male has only 4-5 left and 3 right postorbital thornlets. An irregular median row of 12 (female), resp. 6 (male) indistinct small thorns is found along the nape to she shoulder girdle, but there are no suprascapular or scapular ones.

One larger and one smaller thorn are situated medially close behind shoulder girdle in the female, there being no further thorns on the anterior third of the trunk. Nine irregular median thorns of varying size on the

median third of trunk changing abruptly from the posterior third onward to an irregular double row of thorns, which continues on to the tail, there being a few larger median thorns in the parallely arranged thorns. There is a broad band of thorns along anterior 3/4 of the flattened tail rather than an arrangement of several more or less distinct rows due to the presence on the tail also of probably two very irregular rows of small hooked thorns on each side from the level of the pelvic axils rearward. Tail portion in front of D1 again with an irregular double median row of thorns, but none between dorsal fins. From about pelvic axils to D1 additionally on each side a, partly irregularly doubled row of about 20 small, hooked lateral thorns.

Male also with two small median thorns immediately behind shoulder girdle. No further thorns on back of trunk, but spinules distinctly concentrated along median line. An irregular median row of 17 small thorns (4 to level of pectoral axils) from a short distance in front of pelvic girdle on, changing at level of pelvic axils to an irregular double row which continues over anterior 2/3 of tail length. Four, again median thorns continue the tail pattern rearward, but a short portion in front of D1 without thorns. These also missing between dorsal fins. No lateral tail thorns. A strip of 10-15 hooked malar thorns on each side close to outer margin of disc at level of orbits and spiracles. Alar thorns in a long double row across each pectoral apex, 5-7 in outer, about 14 in inner row.

Colour (in alcohol) – the dorsal colour pattern of both ISH specimens is shown in fig. 7. The ground colour is a distinct brown in the female, a brown-grey in the male, but changes almost to a uniform dark brown towards the median axis of the body, this also being the colour of the tail.

Lower side white except for wedge-shaped dark mark from the tip of the snout over 2/3 of the preoral snout length, a broad greyish-brown margin to the disc and posterior pelvic lobe, and a few small brown spots on the underside of the tail. The female also has a large irregular brown blotch at each pectoral axil. The male's claspers are white.

b) Anatomy (based on radiographs)

Neurocranium (fig. 8) – rostral cartilage solid and broad, tapering evenly to its tip; the length 41.4% (female) and 40.1% (male) of the total length of the cranium. Width of the rostral base 29.9% (♀) and 27.4% (♂) of the greatest cranial width, which is 84.1% (♀) and 98.5% (♂) of the maximum width of the pectoral girdle. *Regio orbito-temporalis* deeply concave, its minimum dorsal width being 32.7% (♀) and 33.5% (♂) of the maximum cranial width and 52.9% (♀) resp. 61.5% (♂) of the

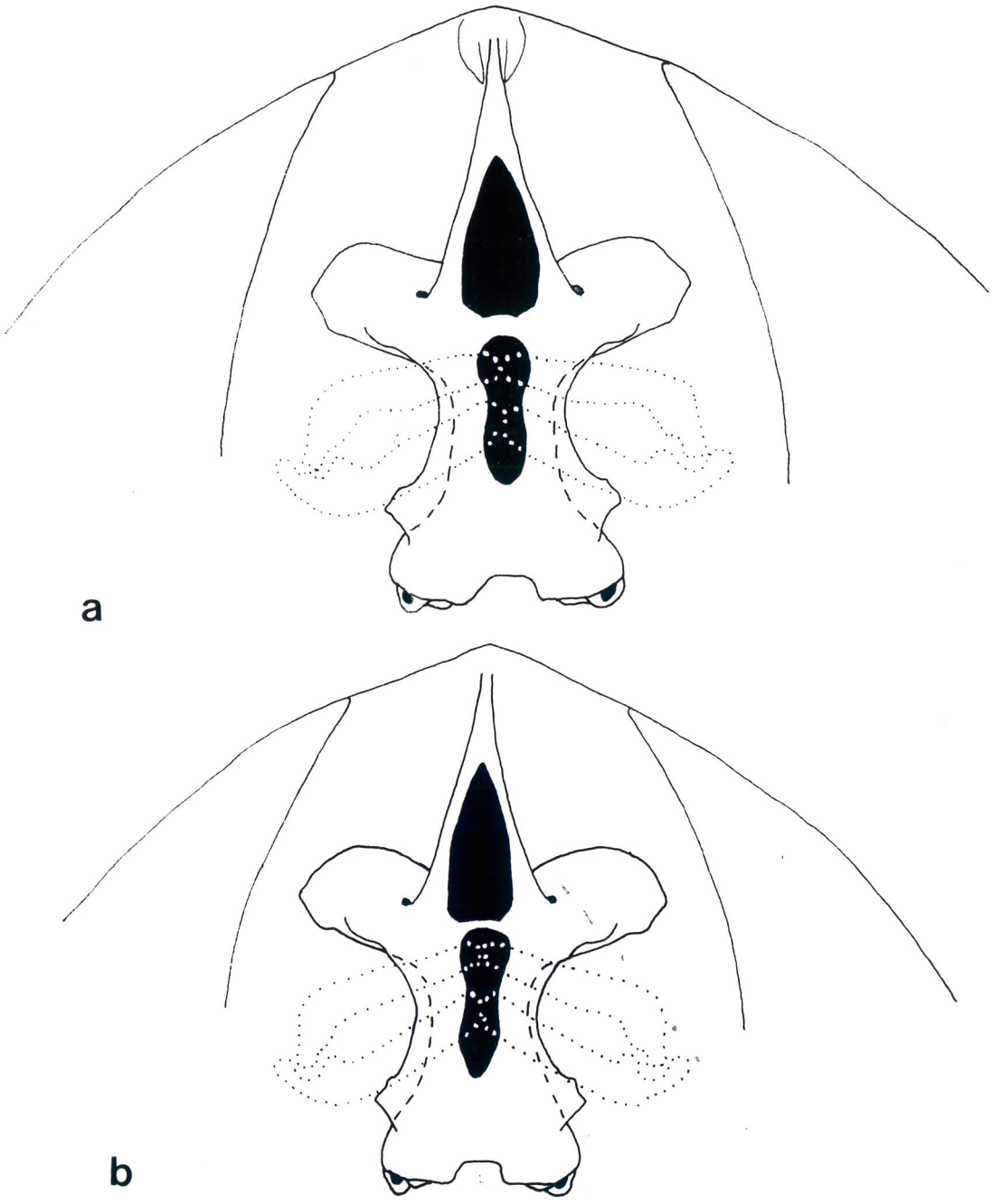

Fig. 8. — *Raja radula* Delaroche, 1809. Neurocrania with snout skeletons of ♀ (a) and ♂ (b) ISH No. 4013a-b/71 in natural size, somewhat schematized after radiographs.

maximum width across the *regio otica*. The latter is short and massive and 61.7% (♀) resp. 54.4% (♂) of the greatest cranial width. Jugular arches distinct and laterally almost level with the contour of the *regio otica*, and rearward almost as long as the occipital condyles. Nasal capsules laterally extended and angular in outline, their nearly straight posterior edges at an angle of 67.5° (♀), resp. 68° (♂) to the longitudinal axis of the skull. Postorbital processes very distinct, the pterotic processes less so. The broad anterior fontanelles, moderately extending to 60.6% (♀) and 52.7 (♂) of the rostral length, are almost drop-shaped, with a trapezoid posterior portion and a slightly concave transverse rear edge which is distinctly behind the level of the greatest cranial width. The posterior fontanelle nearly as long as the anterior one, its shape as the *R. atra* holotype. Forward extension of propterygia with anterior pectoral radials 78.6% (♀) and 73.2% (♂) of the rostral length, but anteriormost radials distinctly falling short of rostral tip.

Pelvic girdle (fig. 9) – maximum width 77.9% (♀) and 78.2% (♂) of the pectoral girdle, and 92.6% (♀) and 79.4% (♂) of the greatest cranial width, the pelvic girdle being 118.9% (♀) and 101.5% (♂) of the latter. Length of prepelvic processes 42.2% (♀) and 37.4% (♂) of the pelvic girdle width. There appears to be sexual dimorphism in that

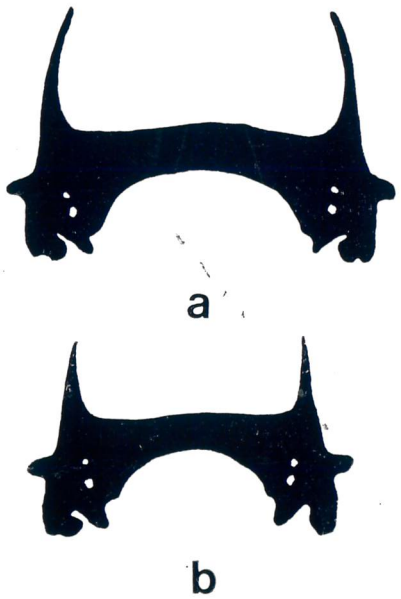

Fig. 9. — *Raja radula* Delaroche, 1809. Pelvic girdles of ♀ (a) and ♂ (b) ISH No. 4013a-b/71 in natural size, somewhat schematized after radiographs.

the male shows somewhat shorter and less curved prepelvic processes. General shape of the pelvic girdle, particularly of the female, as in the *R. atra* holotype.

Vertebrae and pectoral rays (♀ / ♂) – Vtr 29/26, Vprd 49/51, pectoral radials 83/81-82.

Discussion

Since Capapé & Desoutter (1979) correctly discovered that the smaller Paris syntype of *R. atra* in fact is a juvenile *Raja undulata* there is no need to deal further with this specimen here. All that needs to be mentioned here is that these authors also avoided for *R. undulata* any description of the specimen's external characters, nor gave one for the three specimens which they used in their comparison. They dealt with only the ampullae of Lorenzini, meristics, pectoral and pelvic girdle, and neurocranium.

Tortonese's (1956) description of *R. radula* is not detailed enough to be really of use in a comparison with the *R. atra* holotype, but those of Bini (1967) and also Clark (1926) are sufficiently good to allow a comparison of the external characters of both taxa. Both the first two authors also mention the occasional occurrence of dorsally uniformly dark brown specimens without any ocelli, which thus fit with the only diagnostic character of *R. atra* in Müller & Henle's (1841) original account. Capapé & Desoutter (1979: 83) state « with certainty numerous differences » between *R. atra* and *R. radula*, but avoid real specification of evidences. They only mention that differences are « mainly morphological ones concerning the shape of the disc and tail », i.e. an almost quadratic disc with nearly straight anterior margins, and a median longitudinal groove on the tail flanked by a regular row of thorns in *R. atra*. In contrast *R. radula* is said to show a nearly rhombic disc with strongly undulated anterior margins, no groove along the tail, and tail thorns set in interrupted rows. This last character is stated to be sufficient for the separation of the species. In addition certain biometrics, as well as the anatomy of the neurocrania and pelvic girdles are said to be arguments that *R. atra* cannot be mistaken for *R. radula* – again no specification been given. The authors summarize that « the valuation of our various observations gives evidence that *R. atra* is easily distinguished from *R. radula* as well as from *R. undulata*; the species also seems not to correspond with another species described from the Mediterranean or other marine areas ». Such a simple state-

ment is in itself not enough to provide evidence that this is indeed the case.

Firstly, it should be born in mind that the *R. atra* holotype in the Berlin Museum is a more than 140 years old ethanol specimen with a largely destroyed snout which results in quite a number of consequences, i.e. damage, shinkage, fading, and deformation of the neurocranium. Nevertheless the type corresponds almost exactly not only in biometrics to two recent specimens of *R. radula* from the ISH collection and the few measurements given by CLARK (1926) (see table 1), but there are also no real differences in meristics. The same is true also for the general shape of the specimens and their squamation, except for the usual differences found in the spinulation of males. CAPAPÉ (1974), quoted also in CAPAPÉ & DESOUTTER (1979: 83), noted for *R. radula* an alteration of the spinulation with growth, but for the first time one that is contrary to the general and well-known trend found in rajids, and also in the ISH specimens. For species in which the juveniles are almost entirely prickly on the upper side and smooth on the lower, the maturing males usually become more and more smooth in the upper pectoral centers and keep the lower side almost smooth. Females, in contrast, remain spinulose on the whole upper side of the disc with spinules often becoming coarser with age, and furthermore develop ventrally prickles in certain areas, such as the snout, interbranchial space, on the belly, as well as around the anus. The spinulation of the holotype, in so far that it is a large female, is quite normal. CAPAPÉ (1974) may have had aberrant specimens in Tunisian waters. Thus, there is no difference with regard to that feature between *R. atra* and normal *R. radula*. No agreement can here be found with the general statement by CAPAPÉ & DESOUTTER (1979: 83) that meristics can be valued with reservation only, because they are commonly very similar in smaller growing rajids and thus are often not useful as species specific characters. Tooth counts as well as numbers and patterns of thorns, for example, are significant features in many species, and hence similarity or conformity of such values often are the arguments in the identification of a specimen or in decisions concerning a species' status (among other arguments usually).

CAPAPÉ & DESOUTTER (1979: 83) correctly describe the shape of the disc of the Berlin *R. atra* specimen, but this description does not fit their figure 1A of that specimen (figures 1 and 2 of the present paper show clearly the great similarity between the Berlin specimen and the illustration by MÜLLER & HENLE, 1841). But their differentiation of a subquadratic disc with straight anterior margins for *R. atra* and a subrhombic disc with strongly undulated front margins for *R. radula* is not correct. The latter species

has likewise a subquadratic disc with almost straight to weakly convex anterior margins and bluntly angled, rounded outer corners (fig. 7).

The diagnostic character in CAPAPÉ & DESOUTTER of a longitudinal median groove on the tail, flanked by a regular row of thorns, is of no significance for two reasons. The presence of the groove is simply due to shrinkage and is often found in old museum specimens preserved in ethanol. That shrinkage is the reason for the groove in the *R. atra* holotype is underlined by the unnatural inward orientation of the thorns along the sides of the groove (fig. 5, fig. 1C in CAPAPÉ & DESOUTTER), a reature which is also present, even if to lesser degree in the ISH female specimen, although it has only been in preservation since 1971. Furthermore, the thorns along the groove in the holotype are certainly not in a regular parallel row. They are set more or less irregularly (fig. 5), which is the general arrangement of the thorns in this specimen along the back and tail because of the several changes between a median and a doubled row. Again this feature is shown by the large *R. radula* specimens in Hamburg, and appears to be typical for the species according to the literature.

The only external character that remains then to distinguish *R. atra* from *R. radula* appears to be its uniform dorsal colour, and the absence of ocelli. This also has been reported for *R. radula* by some authors (*loc. cit.*). Thus, MÜLLER & HENLE (1841) correctly stated that their larger specimen corresponded with everything shown externally by *R. radula*, except for the colouration, which type they not yet had encountered for the latter species. One feature for which no explanation can here be offered is the snout angle of only 110° in MÜLLER & HENLE's original illustration, except perhaps that this may be distortion within the illustration as is indicated by apparent inaccuracy concerning the width of the disc as a comparison of figures 1 and 2 shows.

Finally, only differences of anatomical features appear to remain. Figures 6 and 8 show the neurocrania of both taxa for comparison with figures 1G and 2F in CAPAPÉ & DESOUTTER. In general these authors not only give a wrong impression of the location of the level of the jugular arches with respect to the *regio otica*, but also of the postorbital and pterotic processes at the dorsal level of the cranium. Their drawing 1G corresponds to fig. 6 given here except for the apparently reconstructed (in which way?) anterior fontanelle and the shape of the posterior one, which is clearly visible in ISH radiographs. Figure 8 here for *R. radula* is also largely in accordance with fig. 2F in CAPAPÉ & DESOUTTER except again for the shape of the posterior and anterior fontanelles, the latter

being much too narrow and long. In the present investigation no significant differences between both taxa could be found.

Concerning the pelvic girdles (figs 6 and 9, figs 1H and 2G in CAPAPÉ & DESOUTTER) the illustrations for the *R. atra* type conform except that the latter authors apparently re-arranged the broken, deformed prepelvic processes. The ISH *R. radula* specimens agree exactly with *R. atra* except for the variation in the male already commented above. But fig. 2G in CAPAPÉ & DESOUTTER is strongly in contradiction to both ISH *R. radula*, because the prepelvic processes are of a different type and with only 20% of the girdle width distinctly shorter. The only explanation can be that they either may have illustrated another species, or a somewhat aberrant pelvic girdle of a *R. radula* male. In connection with the *R. radula* and *R. undulata* illustrations of the CAPAPÉ & DESOUTTER paper it must be considered as a general disadvantage, that these authors have not indicated on which actual specimens of both species the anatomical and detailed illustrations are based. Furthermore, the lack of a scale in most such figures does also not allow, at least, a recalculation of proportions etc. and thus a comparison of species.

Summarizing, there is no evidence at all that the *R. atra* Müller & Henle, 1841 syntype in the Berlin Museum is significantly different from *R. radula* Delaroche, 1809 for it to define a different taxon. The only real difference appears to be the colouration of this specimen. But even in this, aberrant forms are occasionally known in quite a number of species of rajids in general and certainly have been reported for *R. radula* (*loc. cit.*). The second smaller syntype in the Paris Museum has proved likewise to be an unusually coloured specimen of *R. undulata* Lacépède, 1802. Hence, *Raja atra*, re-validated by CAPAPÉ & DESOUTTER (1979), is again referred to the synonymy of *Raja radula*.

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Author's address. — MATTHIAS STEHMANN, Ichthyologie Institut für Seefischerei, Zool. Museum Univ. Hamburg, Martin-Luther-King-Platz 3, D - 2000 Hamburg 13 (Federal Republic of Germany).