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CONTRIBUTIONS TO THE RUNCINIDAE. I. SIX NEW SPECIES OF THE GENUS *RUNCINA* (OPISTHOBRANCHIA CEPHALASPIDEA) IN THE MEDITERRANEAN

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RUNCINA
OPISTHOBRANCHIA
MEDITERRANEAN
RADULA
ORAL ARMATURE
SEM

ABSTRACT. – Six new species of *Runcina* Forbes & Hanley, 1853, are described in this first part of a bipartite article on the Runcinidae, three more will follow in the second part (in press). All but one species are described with live coloration, radula and jaws examined by SEM. Five *Runcina* in this report are from *Posidonia/Zostera* of Banyuls-sur-Mer, France, one from the sand intersticium of Naples, Italy. *Runcina langei* n. sp. is greenish with fine dark green specks, the notum with six paired dark marginal marks and few deep black blotches, a white cross-band behind the eyes and a white rear. *R. kressae* n. sp. is yellowish with three black spotted cross lines, a white cross-band behind the eyes and a white notum rear. *R. hansbechi* n. sp. is covered densely with large, variably shaped, amoeboid black blotches, interspersed with white spots, on a yellowish ground colour. *R. nivale* n. sp. out of the mesopsammon is transparent whitish with very large eyes and gills. *R. banyulensis* n. sp., with exceptionally large eyes, is light beige with small black spots, the notum broadly bordered with white, interspersed with red and brown spots, and bearing a pure white 'T'. *R. avellana* n. sp. is chocolate brown with a lighter foot sole, one blackish brown mark on the clear tail, and clear head sides and front. A morphological introduction to the Runcinidae with emphasis on jaws and radula is given. Dental metamorphosis is observed and reanalysed.

RUNCINA
OPISTHOBRANCHIA
MEDITERRANÉE
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ARMATURE BUCCALE
SEM

RÉSUMÉ. – Six nouvelles espèces de *Runcina* Forbes & Hanley, 1853 sont décrites dans la première partie d'un article sur les Runcinidae qui se compose de deux parties ; 3 autres espèces seront décrites dans la seconde partie. La couleur sur le vivant est indiquée pour toutes les espèces, la radula et les mâchoires sont examinées au microscope électronique à balayage. Cinq *Runcina* de Banyuls/Mer (France) vivent sur *Posidonia* et *Zostera*, une espèce provient du sable interstitiel de Naples (Italie). *Runcina langei* n. sp. est verte tachetée de vert sombre, le notum montre 6 empreintes marginales, paires et sombres et quelques profondes marbrures noires, une bande transversale blanche derrière les yeux et une extrémité arrière blanche. *R. kressae* n. sp. est jaunâtre avec 3 rangées transversales de points noirs, une bande transversale à l'arrière des yeux et la partie distale du notum blanche. *R. hansbechi* n. sp. est densément couverte de larges marbrures noires à la forme amiboïde variable, interrompues de points blancs sur fond jaune. *R. nivale* n. sp., provenant des interstices du sable, est transparente, blanchâtre, avec des yeux et des branchies de forte taille. *R. banyulensis* n. sp., pourvue de grands yeux de taille exceptionnelle, est beige clair avec de petits points noirs, un notum marqué d'une large bordure blanche interrompu par des points rouges et bruns et d'un T blanc pur. *R. avellana* n. sp. est brun chocolat, avec une semelle pédieuse plus claire, une marque brun-noir sur la queue claire, et les côtés de la tête et le front clairs. L'introduction sur la morphologie des Runcinidae porte en particulier sur les mâchoires et la radula. La métamorphose des dents est observée et réanalysée.

To the late T.E. Thompson

INTRODUCTION

Runcina Forbes & Hanley, 1853, belongs to the marine euthyneuran gastropods, the Opisthobranchia. Unlike Franc (1968) who created a separate order Runcinacea we agree with Burn (1963), Ghiselin (1963), Baba (1967), Marcus & du Bois-Reymond Marcus (1970), Kress (1977), Schmekel (1985), Thompson & Brodie (1988), Gosliner (1990, 1991), Cervera *et al.* (1991) and Mikkelsen (1993, 1996), that the Runcinacea should be retained as a suborder within the Cephalaspidea. Most *Runcina* are small animals with a very characteristic colour and shape. We describe nine new species from Banyuls and Naples, six in this publication and three in the following work (Schmekel & Cappellato 2002 in press). They all belong to the genus *Runcina*. In part II the reader will find a redescription of *R. coronata* (Quatrefages, 1844) from the locus typicus, and an account of Mediterranean *R. adriatica* Thompson, 1980, *R. africana* Pruvot-Fol, 1953, *R. brenkoeae* Thompson, 1980, and *R. ferruginea* Kress, 1977, all with SEM analyses of radula and jaws, to render these established species comparable with our new ones.

In the **Runcinacea** (Odhner, 1939) the dorsum is not divided transversely into two shields, the foot is undivided and without lateral extensions or parapodia. The position of the anus is terminal under the posterior mantle, (often) median or slightly to the right of the median line. The branchiae are small and positioned around or to the right of the anus, or absent. An outer (*Ildica* Bergh, 1889) or inner rudimentary shell may be present. It is mostly absent in *Runcina* Forbes & Hanley, 1853, *Runcinella* Odhner, 1924, *Runcinida* Burn, 1963 and *Ilbia* Burn, 1963. When present the inner shell is haliotiform, very fragile, small and terminal in position. There are no cephalic tentacles; oral tentacles are present only in *Ildica*. Jaws (oral armature) are present. The adult radula has in each row a broad rachidian tooth and one or two pairs of lateral teeth. Obsolete teeth are discarded and not retained in a special sac. A grinding gizzard containing four equal plates is present in most genera (not in *Ilbia* Burn, 1963 or *Pseudoilbia* Miller and Rudman, 1968). An operculum is lacking even in the embryonic stage. The euthyneurous nervous system forms a ganglionic ring with fused cerebropleural ganglia posterior to the buccal mass (Marcus & du Bois-Reymond Marcus, 1970). The common genital orifice lies often one third of the body length anterior to the anus, in the right mantle furrow, or adanal (rarely). There is an open seminal groove leading to the adoral male opening, situated on the right side, with retractile penis, prostate gland and seminal vesicle. The anterior pallial ectodermal genital organs are monaulic.

For more detailed subdivision of this group two proposals were brought forward by Burn (1963) and Baba (1967) (compare Kress 1977). Baba (1967) retains one large family, which contains all genera – Burn (1963) proposes two families: the Ildicidae and the Runcinidae. We, for the present, follow Burn (1963) like Thompson & Brodie (1988), Gosliner (1991) follows Baba (1967).

The **Runcinidae** (Burn, 1963) are without an external shell, without or with a rudimentary inner shell; without (seldom) or with up to four gills. The gills are on the right side of the anus or around it; they may be plates or plumes. The radular formula is 1.1.1 (most species) or 2.1.2. The rachidian teeth are uni- or bicuspidate (bilobed) or may be reduced. In most species they bear two pads with denticles. The laterals are hooks with smooth or denticulate cutting edges. The oral cuticula is smooth or may have jaws. The common genital pore is adanal (*Runcinella*) or more anterior (most species), one third of the body length anterior to the anus. Currently there are six genera: *Runcina* Forbes & Hanley, 1853; *Metaruncina* Baba, 1967; *Runcinella* Miller & Rudman, 1968; *Runcinida* Burn, 1963; *Ilbia* Burn, 1963; *Pseudoilbia* Miller & Rudman, 1968. Thompson & Brodie (1988) are of the opinion that the genus *Runcinida* is synonymous with *Runcina*.

Genus *Runcina* Forbes & Hanley, 1853 (p. 611-612):

The type species is *Pelta coronata* Quatrefages, 1844 (see description part II, Pl. 3). The name *Pelta* was suppressed in 1967 (compare Lemche 1965; Opinion 811, 1967, Bull. Zool. Nomencl. 24 (2): 89-90), and *Runcina* again became the valid name. There are up to four separate gills, close to the posteriorly placed hyponotal anus. In most species the gills are rounded plates on the right side of the anus. *Runcina coronata* and most other species are without internal shell. The radular formula is 1.1.1, median teeth are bilobed with denticles, laterals are smooth or denticulate. The common genital orifice is in the type species one third of the body length anterior to the anus. The male genital apparatus (opening adorally) has a penis and two vesicles: prostate gland and seminal vesicle. There may be an opaline gland.

Recently there have been many new descriptions of *Runcina* species in the eastern Atlantic and the Mediterranean: *R. ferruginea* Kress, 1977; *R. adriatica* Thompson, 1980; *R. brenkoeae* Thompson, 1980, *R. zavodniki* Thompson, 1980; *R. aurata* Garçía, López, Luque & Cervera, 1986; *R. lenticula* Gofas, Ortea & Rodríguez, 1991; *R. macrodenticulata* Garçía, Garçía-Gómez & López de la Cuadra, 1990; *R. paupera* Ortea, Rodríguez & Valdés, 1990; *R. falciforme* Ortea, Rodríguez & Valdés, 1990; *R. bahiensis* Cervera, Garçía-Gómez & Garçía, 1991. Thompson & Brodie (1988) review the Mediterranean species and genera and summarise the diagnostic features of the world's species of *Runcina*. Kress (1977), Gosliner (1991) and Cervera *et al.* (1991) give us very helpful tables. Table I (Part II: Schmekel & Cappellato, 2002) lists the main features of the new and the already established species in the Mediterranean and the eastern Atlantic reported in the two parts of this article. In part II (Schmekel & Cappellato, 2002) a synop-

sis summarizes the characteristic features of the world's species of Runcinacea.

The morphology of the Runcinidae

Because the anatomy of this family is scarcely known, we here provide an extensive morphological account of the organs relevant to the description of the species in this study. The basic organisation of the Runcinidae (Burn, 1963) has been well analysed by Odhner 1924, Baba 1967, Ghiselin 1963, and Kress 1977.

In this family there are some very well analysed species. On the other hand there are many genera and species incompletely analysed and sometimes comprising only one specimen. Therefore it is difficult to determine which character state is plesiomorphic and which is apomorphic. Synapomorphic in this group are the undivided notum, four gizzard plates, and the terminal and median anus. Mikkelsen (1996) recently developed the first cladistically generated, testable morphology-based phylogeny for cephalaspids. One of the best known species is *Metaruncina setoensis* (Baba, 1954). We know its anatomy (Baba 1967, Ghiselin 1963), its embryology (Baba & Hamatani 1959), and its feeding habits (Ghiselin 1963). In *R. ferruginea* Kress, 1977, and partly in *R. coronata* (Quatrefages 1844) we know much about the fine structure: spermatophores (Kress 1985 a); male copulatory apparatus (Kress 1985 b); female genital glands of the oviduct (Kress & Schmekel 1992); digestive gland (Kress *et al.* 1994).

Ectoderm and exterior morphology: the notum may be oval (Pl. III a) or violin-shaped (Pl. II e) or more or less square (Pl. III f). The anterio-lateral border of the mantle is often somewhat enlarged and raised (Pl. I b, m), which is called 'head lobes' by us. The notum is mostly smooth or may bear weak tubercles. There may be very small oral bulbs (Pl. I b). Foot sole and notum often are more or less equal in size, but sometimes the foot sole slightly extends the notum (Pl. II l). The mantle furrow is mostly narrow (Pl. I b), sometimes broad (Pl. I a). In the right mantle furrow we find: in a median anterior position the mouth (Pl. I b), adorally the penis-opening (Pl. I d) and the seminal groove running towards the common genital pore (Pl. I a, II/3 a). In *Runcina* Forbes & Hanley, 1853, the common genital aperture lies one third from the posterior end, in *Runcinella* Odhner, 1924, it lies adanal. Near the anus there often is an opaline gland of unknown function. Peters (1993) did not find a Hancock organ with SEM + TEM studies. The left mantle furrow is without characteristic structure even in our SEM analyses. The size (Pl. I d, part II) and position (Pl. I c, part II) of the eyes vary, according to species and age.

The ground colour results from the combination of the transparent epithelium and of the hemolymph liquid. The gonad and the midgut gland themselves (viscera) mostly are pigmented. In most species the coloration and pattern are very constant (e. g. *R. hornae* Schmekel & Cappellato, in press, Pl. I c, part II), *R. brenkoae* Thompson, 1980, Pl. III a) – on the other hand there are species which are very variable (*R. langei* n.sp., Pl. IV e; *R. kressae* n. sp., Pl. III d; *R. africana* Pruvot-Fol, 1953, Pl. I, e, f, part II; compare Cervera *et al.* 1991). Within many species the opaque white pattern is more constant

and more characteristic than the dark one. The position of the black "pigment" may be species characteristic, but some details occur in more than one species; e.g. the dark marks on the base of the tail appear in *R. langei* (Pl. IV e), *R. hornae*, *R. banyulensis* n.sp., *R. kressae* (Pl. III d), and *R. elongata* n.sp. (in press), and the opaque white cross band behind the eyes occurs in *R. adriatica* (Pl. III e, f), *R. kressae* (Pl. III d), *R. banyulensis* (Pl. IV f), *R. langei* (Pl. IV e).

Shell: *Ildica* Bergh, 1889 (Curaçao, perhaps partly digested; not refound) has an adult external shell. Du Bois-Reymond-Marcus & Marcus (1963) and Marcus & du Bois-Reymond Marcus (1970) describe their adult *Lapinura divae* with a small external larval shell. Clark (1984, Bermudas) found a population of probably this species but only one third of the adult animals have a minute veliger shell (0.2 mm). We did not find an internal shell in serial sections and after NaOH maceration of *R. coronata*, *R. ferruginea*, *R. adriatica*, *R. africana*, *R. langei*, *R. kressae* and *R. hornae*. An inner shell is present in *Metaruncina setoensis* (Baba, 1954; fig. 1b: haliotiform); *Runcina australis* Burn, 1963 (Fig. 10, calcareous 0.1 mm); *R. katipoides* Miller & Rudman, 1968 (bean-shaped, Fig. 26); *Runcina marshae* Burn, 1963 (Fig. 3). Ortea & Rodríguez (1993) describe a large, dorsal, internal conjunctive plate for their *Runcinella thompsoni*. It looks very different from the shells described above.

Gills (Pl. I a, f – h, Pl. I a, e, part II, Pl. IV a, b): The gills are situated adanally in various positions (Burn 1963): They may surround the anus, be situated on both sides of it or only on the right side. The gills may consist of plumes or plates which may be subdivided (figured first by Alder & Hancock, 1846: Pl. IV, fig. 1, 5) or may be very small or absent. In all species from Banyuls they are on the right side of the anus or absent. The SEM confirms that they are rounded plates (Pl. I f), which may be subdivided (Pl. I g, h), often forming a stout whorl (Pl. I h). Depending on the direction of microscopical sections the subdivided plates may give the impression of plumes (see *R. ferruginea* Kress, 1977, fig. I D).

Oesophagus: the alimentary tract begins with the ectodermal oesophagus with the short, muscular buccal mass containing paired chitinous jaws and radula sac, followed by the gizzard with four chitinous masticatory plates.

Jaws (oral cuticular armature, Pl. VIII f, IV b, part II). The jaws (Pl. IV b) are triangular plates situated laterally. They seldom are smooth. In most of our material the SEM reveals a field of erect scales arranged densely and regularly plus one row of plates with prongs (Pl. I c). Towards the edges of the jaws and towards the gizzard the scales often are broader and less erect (Pl. VII e, g). Most of the scales are shell-shaped with one half of the "shell" slightly overlapping the other at the rim (Pl. I c, V d, e). The scales often show species characteristic differentiations: the rim may be bulgy (*R. langei*, Pl. V d) or sharp (*R. kressae*, Pl. VI g). The scales may have grooves at the rim or on their body. The grooves may (*R. hansbechi*, Pl. VII g) or may not fork (*R. langei*, Pl. V e). The pronged plates, lying flat on the matrix of the jaws, form the border facing the mouth (Pl. I c). Their processes are presumably sometimes specific in their shape (*R. africana*, Pl. V f, part II, *R. ferruginea*, Pl. VI h, part II). As preparation of the jaws is difficult, in many examined species they can only be

Plate I. – SEM micrographs of various aspects of *Runcina*. **a**, *Runcina langei* Schmekel & Cappellato, 2001, caudal right side; arrow: genital orifice, double arrow: seminal groove; **b**, *R. langei*, mouth region; F foot, arrow: small oral bulbs; **c**, *R. langei*, mouth with protruded jaws (*hyperthermic stress* method), dorsal view; P plates with prongs; S scales; **d**, *R. adriatica* Thompson, 1980, front region with protruded jaws (*hyperthermic stress* method; arrow) and penis (P); F foot; **e**, *R. africana* Pruvot-Fol, 1953, spermatophore in the notal furrow; **f**, *R. ferruginea* Kress, 1977, view onto foot surface; anus (arrow), gill with spermatophore (S) beneath it; N notum; **g**, *R. brenkoeae* Thompson, 1980, caudal view, gill; note cilial fields; F foot; **h**, *R. langei*, lateral aspect of gill; note cilial fields; N notum.

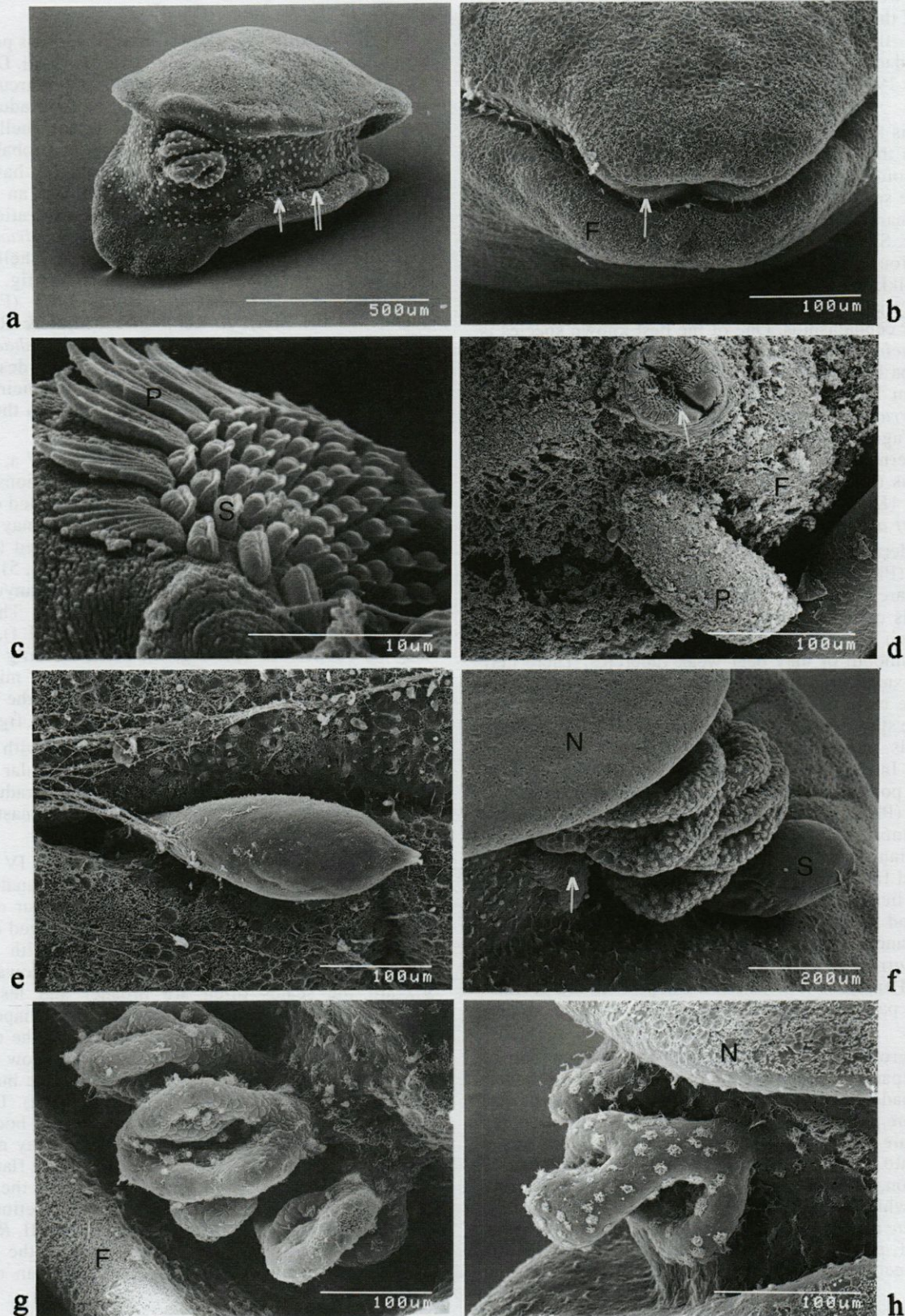
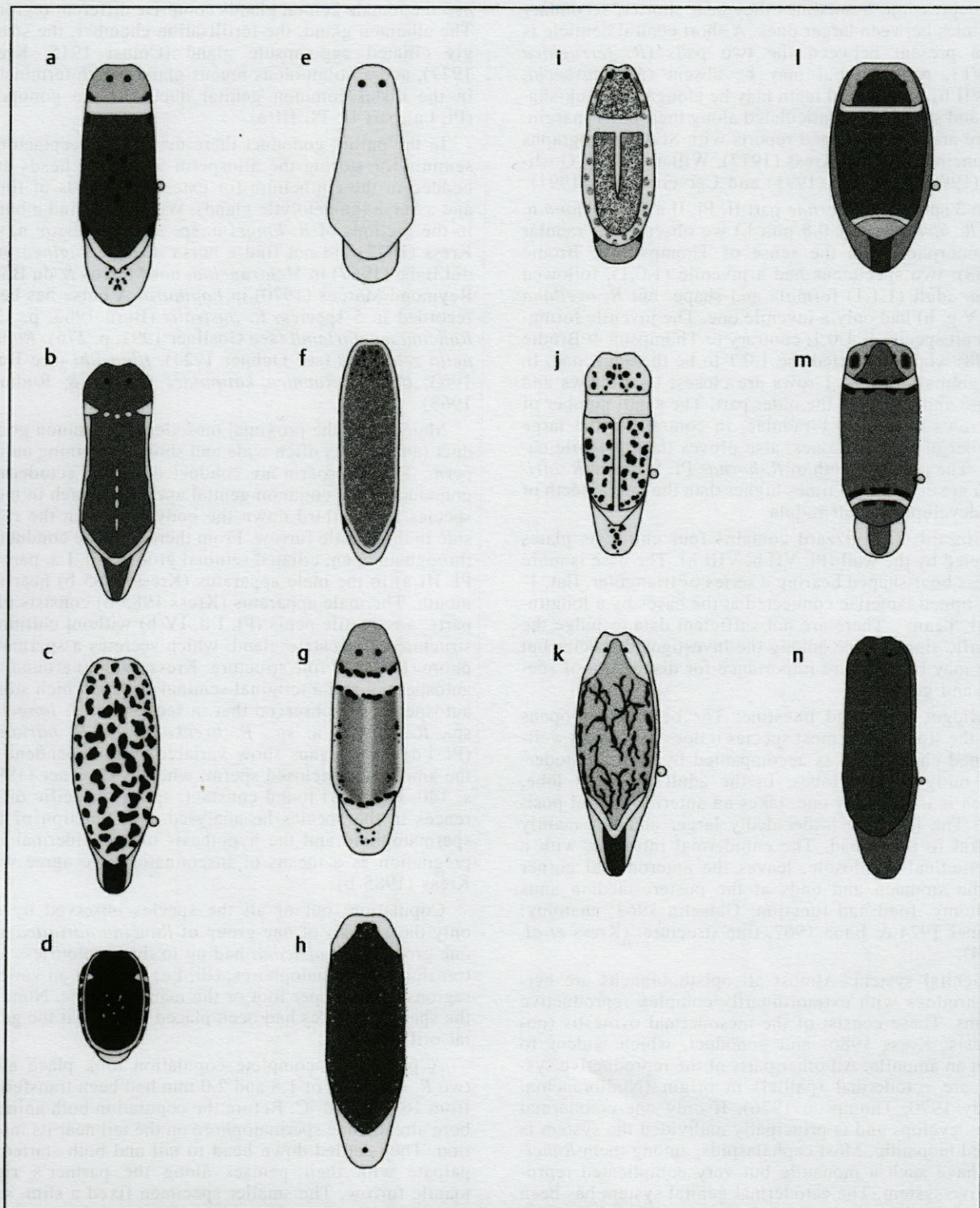


Plate II. – Schematic illustration of the new species and the known species of *Runcina* described in the two parts of this study; small circle to the animal's right indicates relative position of the genital orifice, if known. **a**, *R. langei* Schmekel & Cappellato n. sp.; **b**, *R. hornae* Schmekel & Cappellato n. sp. (description in part II, in press); **c**, *R. hansbechi* Schmekel & Cappellato n. sp.; **d**, *R. rotunda* Schmekel & Cappellato n. sp. (description in part II, in press); **e**, *R. nivale* Schmekel & Cappellato n. sp.; **f**, *R. elongata* Schmekel & Cappellato n. sp. (description in part II, in press); **g**, *R. kressae* Schmekel & Cappellato n. sp.; **h**, *R. avellana* Schmekel & Cappellato n. sp.; **i**, *R. banyulensis* Schmekel & Cappellato n. sp.; **j**, *R. adriatica* Thompson, 1980 (description in part II, in press); **k**, *R. brenkoae* Thompson, 1980 (description in part II, in press); **l**, *R. coronata* (Quatrefages, 1844) (description in part II, in press); **m**, *R. africana* Pruvot-Fol, 1953 (description in part II, in press); **n**, *R. ferruginea* Kress, 1977 (description in part II, in press).



shown from the reverse side, which is the side of secretion. When seen from the reverse side the scales are bowl- or saucer-shaped Pl. VI h, part II).

Radula: The radular formula (in press Pl. V a, part II) is usually 1.1.1 (Pl. VII a-d), seldom 2.1.2, or the radula may be reduced to several aberrantly shaped teeth in disarray (Baba 1954, Ghiselin 1963). The rachidian teeth are broadly horseshoe-shaped, seldom uni- but mostly bicuspidate (bilobed) and with denticles of variable and often species-characteristic shape on either side of a central depression. Sometimes they bear shorter, secondary denticles between larger ones. A short central denticle is often present between the two pads (*R. ferruginea* Pl. VI f, part II), but may be absent (*R. hansbechi*, Pl. VII b). The lateral teeth may be elongated, hook-shaped and smooth or denticulated along their outer margin. There are five published reports with SEM micrographs of runcinid radulae: Kress (1977), Willan (1981), Gosliner (1990), Gosliner (1991) and Cervera *et al.* (1991).

In 3 species (*R. hornae* part II, Pl. II a; *R. avellana* n. sp., *R. africana*, 0.7-0.8 mm l.) we observed a 'radular metamorphosis' in the sense of Thompson & Brodie (1988): two specimens had a juvenile (1.0.1), followed by an adult (1.1.1) formula and shape, but *R. avellana* (Pl. V g, h) had only a juvenile one. The juvenile formula in all species is 1.0.1, contrary to Thompson & Brodie (1988) who interpreted the 1.0.1 to be the adult one. In our animals the 1.0.1 rows are closest to the jaws and mouth and therefore the older part. The small number of 3-5 rows in the 1.0.1 radulae, in contrast to the large number of the adult ones, also proves their juvenile nature. The juvenile teeth of *R. hornae* Pl. V a) and *R. africana* are curiously 3 times higher than the lateral teeth of the developing adult radula.

Gizzard: The gizzard contains four chitinous plates secreted by the wall (Pl. VII h, VIII h). The base is more or less boat-shaped bearing a series of triangular, flat, 1- to 3-tipped lamellae connected at the bases by a longitudinal "beam". There are not sufficient data to judge the specific significance among the investigated species but they may be of future importance for discussion of species and genera.

Midgut gland and intestine: The oesophagus opens into the stomach. In most species it does not form a well-defined chamber. It is accompanied by paired entodermal midgut gland lobes. In the adult the right lobe, which is the smaller one, takes an anterior-ventral position. The left lobe is decidedly larger and lies mainly ventral to the gonad. The entodermal intestine, with a longitudinal typhlosole, leaves the anterodorsal corner of the stomach and ends at the postero-median anus (anatomy, food and function: Ghiselin 1963; anatomy: Odhner 1924 & Baba 1967, fine structure: (Kress *et al.* 1994).

Genital system: Almost all opisthobranchs are hermaphrodites with extraordinarily complex reproductive organs. These consist of the mesodermal ovotestis (oogenesis: Kress 1986) and gonoduct, which widens to form an ampulla. All other parts of the reproductive system are ectodermal (pallial) in origin (Nudibranchia: Tardy 1970, Thompson 1976). If only one ectodermal tube develops and is principally undivided the system is called monaulic. Most cephalaspids, among them *Runcina*, have such a monaulic but very complicated reproductive system. The ectodermal genital system has been histologically examined as far as possible in the new

species. Among the few species with abundant material available, these parts do not seem to differ much, and are similar to those of *R. ferruginea* Kress 1977. Little is known about the variability of the ectodermal genital system due to age and species.

Female ectodermal apparatus: This system is well studied in *Metaruncina* Baba, 1967, *Runcinella* Odhner, 1924, *R. coronata* (Quatrefages, 1844) and *R. ferruginea* Kress, 1977 (Kress & Schmekel, 1992). In most other species it is scarcely known or not at all. In *R. ferruginea* the female genital glands comprise different regions: The albumen gland, the fertilisation chamber, the strongly ciliated egg-capsule gland (Colosi 1915, Kress 1977), and a voluminous mucus gland which terminates in the distal common genital duct and the gonopore (Pl. I a, part II: Pl. III a).

In the pallial gonoduct there may be a receptaculum seminis for storing the allosperm with their heads embedded in the epithelium for extended periods of time, and a bursa (gametolytic gland). We did not find a bursa in the sections of *R. langei* n. sp. and *R. kressae* n. sp. Kress (1977) did not find a bursa in *R. ferruginea*, nor did Baba (1967) in *Metaruncina*, nor Marcus & du Bois-Reymond Marcus (1970) in *Lapinura*. A bursa has been recorded in 5 species: *R. australis* (Burn 1963, p. 13); *Runcina macfarlandi* (see Gosliner 1991, p. 276); *Runcinella zelandica* (see Odhner 1924), *Ilbia ilbi* (see Burn 1963, p. 18); *Runnica katipoides* (Miller & Rudman 1968).

Male ducts: the proximal mesodermal common gonoduct (ampulla) is often wide and short, containing autosperm. The autosperm are conducted via the ectodermal gonoduct to the common genital aperture, which in most species is two third down the body length on the right side in the mantle furrow. From there they are conducted through an open, ciliated seminal groove (Pl. I a, part II: Pl. III a) to the male apparatus (Kress 1985 b) near the mouth. The male apparatus (Kress 1985 b) consists of 3 parts, a retractile penis (Pl. I d, IV b) without chitinous structures, a prostate gland, which secretes a spermatophore (Pl. I e, f; fine structure: Kress 1985 b) around the autosperm - and a terminal seminal vesicle which stores autosperm. We observed that in sections of *R. langei* n. sp., *R. kressae* n. sp., *R. brenkoae* and *R. adriatica* (Pl. I d) both organs show variable sizes dependent on the amount of enclosed sperm, whereas Gosliner (1990, s. 140, Fig. 5 B) found constant, species-specific differences in the species he analysed. For function of the spermatophore and the hypothesis of subepidermal impregnation as a means of insemination, we agree with Kress (1985 b).

Copulation: out of all the species observed by us, only the animals of one group of *Runcina adriatica* and one group of *R. africana* had up to three colourless and translucent spermatophores. (Pl. I e) attached on various regions of the upper foot or the mantle furrow. None of the spermatophores had been placed directly at the genital orifice.

A probably incomplete copulation took place after two *R. adriatica* of 1.8 and 2.0 mm had been transferred from 16 °C to 20 °C. Before the copulation both animals bore already one spermatophore on the tail near its insertion. They settled down head to tail and both started to palpate with their penises along the partner's right mantle furrow. The smaller specimen fixed a slim, sausage-shaped and milky-white spermatophore ventrally

into the mantle furrow, a distance behind the genital orifice of the partner. The passing of the spermatophore could be seen through the transparent penis. Then the animals separated immediately. The copulation lasted only 2 to 3 minutes (result of artificial environment?); the spermatophore was expelled within 20 seconds. An hour later the spermatophore looked swollen, oval, taut and more transparent. Neither specimen spawned within two days after copulation.

Development: A spawn consists of few and large eggs rich in yolk (Ros 1981), e.g. in *R. coronata* (Quatrefages, 1844), *Metaruncina setoensis* (Baba, 1954), and *R. ferruginea* Kress, 1977. The development is 'direct' (intracapsular, without freely swimming veliger) in *R. coronata* (Vayssière, 1900), *Runcinida elioti* (Baba, 1937, see Baba & Hamatani 1959), *Metaruncina setoensis*, and *R. ferruginea*. There is a remarkable study on the ontogenesis in *M. setoensis* by Baba and Hamatani (1959). We do not know if all species have such direct development. Ghiselin (1963) and Gosliner (1990) emphasised the phylogenetic value of this development type.

Though the majority of species seems to be very local (no free swimming veliger stage), in the discussion of our new species we consider all world-wide known, externally similar species.

MATERIAL AND METHODS

Schmekel collected Mediterranean runcinids in addition to Saccoglossa and Nudibranchia in Naples, Italy, 1965-1970, Portmann and Sandmeier-Fioroni 1958 at Observatoire Arago, Banyuls-sur-Mer (42°N; 3° E), France. Both authors collected intensively since 1993 at Observatoire Arago, Banyuls. *Runcina coronata* were hand-sampled from tidal pools near the upper littoral fringe in Roscoff (Bretagne, Atlantic, France) at low tide in spring 1972-74, *R. ferruginea* collected in August 1974/November 1975 by Kress in Plymouth. Almost all other species were collected at Banyuls from rhizomes of *Posidonia*, *Zostera*, *Cymodocea* or small algae, mainly by diving or dredging at 0-30 m, and some at Naples (Italy). The algae or rhizomes were left undisturbed some hours up to 2 days in bowls with seawater. Under these conditions *Runcina* spp., searching for oxygen, climb to the surface. The animals were relaxed with 7% MgCl in aqua dest. Some were fixed in 7% formaldehyde in seawater but most in acid Bouin's solution in aqua dest (Romeis, 1968, N° 304, p. 73). After dehydration through an alcohol series, the specimens were retained in 70% alcohol. 1-3 specimens each of *R. hornae* n. sp. (part II, in press), *R. kressae* n. sp., *R. langei* n. sp., *R. adriatica* Thompson, 1980, *R. africana* Pruvot-Fol, 1953, *R. brenkoae* Thompson, 1980, *R. coronata* (Quatrefages, 1844), and *R. ferruginea* Kress, 1977 were analysed histologically. For light microscopy, paraffin-embedded material was serially sectioned longitudinally and transversely at 5µm. The slides were stained with May-Grünwald-Giemsas, Hemalaun-Chromotrop and Alcianblue (Romeis 1968). For scanning electron microscopy (SEM), animals fixed in Bouin's solution were dehydrated in ethanol, critical point dried (c.p.d.) with CO₂ and coated with gold. SEM was carried out on a Hitachi S-530.

For the examination of jaws lining the pharynx in their natural position, living specimens were heated for several minutes in their small water bowl under a hot lamp. With this *hyperthermic stress* method the animals protrude their mouth and expose their jaws. The technique didn't work in all species.

All radular formulae and measurements for jaws, teeth and gizzard plates are the maximum evaluated for each species, unless otherwise noted.

Abbreviations: b.: broad; comp.: compare; c.p.d.: critical point dried; fix.: fixated; h.: height; l.: length; Lab.: Observatoire; Mus.: Museum; rad.: radula; spec.: specimen; w.: width

RESULTS

Runcina langei Schmekel & Cappellato n. sp. (Pl. II a, IV e, V, I a-c, h, part II, Table I)

Material: 180 specs., 0.5-2.0 mm l., Banyuls 1995-1997, most from 1997, none in 1998, ca. 5-15 m depth, common among rhizomes of *Posidonia*, *Zostera*, *Cymodocea*, and small algae by dredging or diving, from Racou to Cap l'Abeille; holotype and paratypes at Senckenberg Mus., Frankfurt, No SMF 322848, 322849, 322850. Paratype I: March 28th, 1996, Racou, night dredge, *Posidonia* rhizomes, 5-8 m; paratype II: March 24th, 1997, *Posidonia* rhizomes and small rock outside the Observatoire Arago at 4-8 m.

Description of the living holotype (Racou, night dredge, March 28th, 1996, 5-8 m; Pl. IV e) of 1.9 mm l., 0.5 mm w, and 0.4 mm h. Rather agile species. Body shape rounded with an angular head and distinct head lobes (Pl. II a). Smooth notum with straight or notched anterior edge, posterior notum end forming a slightly raised tip. Widest and highest part of the body just anterior to the notum end. Foot as wide as notum, long and rounded tail (0.5 mm l.). Eyes of medium size in medium depth, close to the anterior end of the head. Anus terminal, just to the right of the median line, common genital pore one third of the body length anterior to it (Pl. II a). With SEM a large spec. (1.2 mm c.p.d.), not the holotype, has 2 rounded gill laminae to the right of the anus, the smaller and undivided one more dorsal and closer to the anus, the bigger one further to the right and divided into 2 or 3 horizontal arcs (Pl. I h).

Ground colour translucent yellowish green, with a light yellow margin. Whole animal covered with fine olive green specks, typically denser around the eyes and along the notal margin. Olive green viscera visible through the notum, right above them few blackish blotches (Pl. IV e). A broad, straight band of small, round, dense, opaque white spots crosses the notum behind the eyes. Notum rear rather broadly bordered with white spots, following the outline of the notum (Pl. II a). The white cross-band and the white of the notum rear continue ventrally through the notal furrow onto the upper foot.

Plate III. – Light micrographs. **a**, *Runcina brenkoe* Thompson, 1980, adult, 2 mm length (description in part II, in press); **b**, *R. brenkoe* juv., 1 mm length (description in part II, in press); **c**, *R. hansbechi* Schmekel & Cappellato n. sp. holotype, 1.4 mm length; arrow: contracted head region; **d**, *R. kressae* Schmekel & Cappellato n. sp. fix. 0.6, 0.9 mm length (holotype); **e**, *R. adriatica* Thompson, 1980, 1.9 mm length; variety with black spots beneath the opaque white of the notum rear; **f**, *R. adriatica*, 1.6 mm length; note black blotches filed up in longitudinal and transverse lines.



Some scattered fine blackish specks along the notal margin, accumulated to form three striking, paired, marginal black marks anteriorly and posteriorly to the white cross-band behind the eyes, and anteriorly to the white notum rear (Pl. II a). Like the white cross-band, the black marks run down through the notal furrow onto the upper foot just beneath their positions, most prominent at the insertion of the tail. Translucent tail with a number of fine black specks on its centre and a border of small white spots on its sides. Foot sole greenish, without any white and black pigment. Colour varieties: this is a very variable species. The ground colour can be more greenish with a brownish-orange tinge. Viscera light green to dark olive green.

Dark marks close to the white notal areas sometimes faint on the light colour variety. White cross-band behind the eyes sometimes discontinuous. White area at the notum rear rarely absent. In some specimens the white spots are so dense that the animals appear whitish all over.

Anatomy: Jaws (Pl. V d, e) of a 1 mm (fix.) animal set with shell-shaped scales, their rims orientated transversely towards the mouth. Each rim shaped as a smooth big bulge (Pl. V e). Basal to it a couple of very fine, vertical, parallel, straight and unforked grooves on the side facing the stomach, (Pl. V d), running down about one third of the body of the scales. Towards the mouth similar grooves run through the horizontal furrow just below the

Plate IV. – Light micrographs. **a**, *Runcina nivale* Schmekel & Cappellato n. sp. holotype, 2 mm length of fixated animal, note large eyes and gills; **b**, *R. adriatica* Thompson, 1980, 1.2 mm length, after short exposure to Na OH; dotted outline: penis, arrow: jaws, double arrow: radula; **c**, *R. avellana* Schmekel & Cappellato n. sp. holotype, 1.2 mm length; **d**, *R. sp.* 0.6 mm length, green variety of *R. avellana* or n. sp. ?; **e**, *R. langei* Schmekel & Cappellato n. sp. holotype, 0.8 mm length; **f**, *R. banyulensis* Schmekel & Cappellato n. sp. holotype, 1.1 mm length, note large eyes close to the front.



bulge, but do not exceed the furrow. 9 plates (Pl. V d), three times larger than the scales, with 7-9 densely parallel and fairly pointed prongs ($1.8 \mu\text{m l.}$).

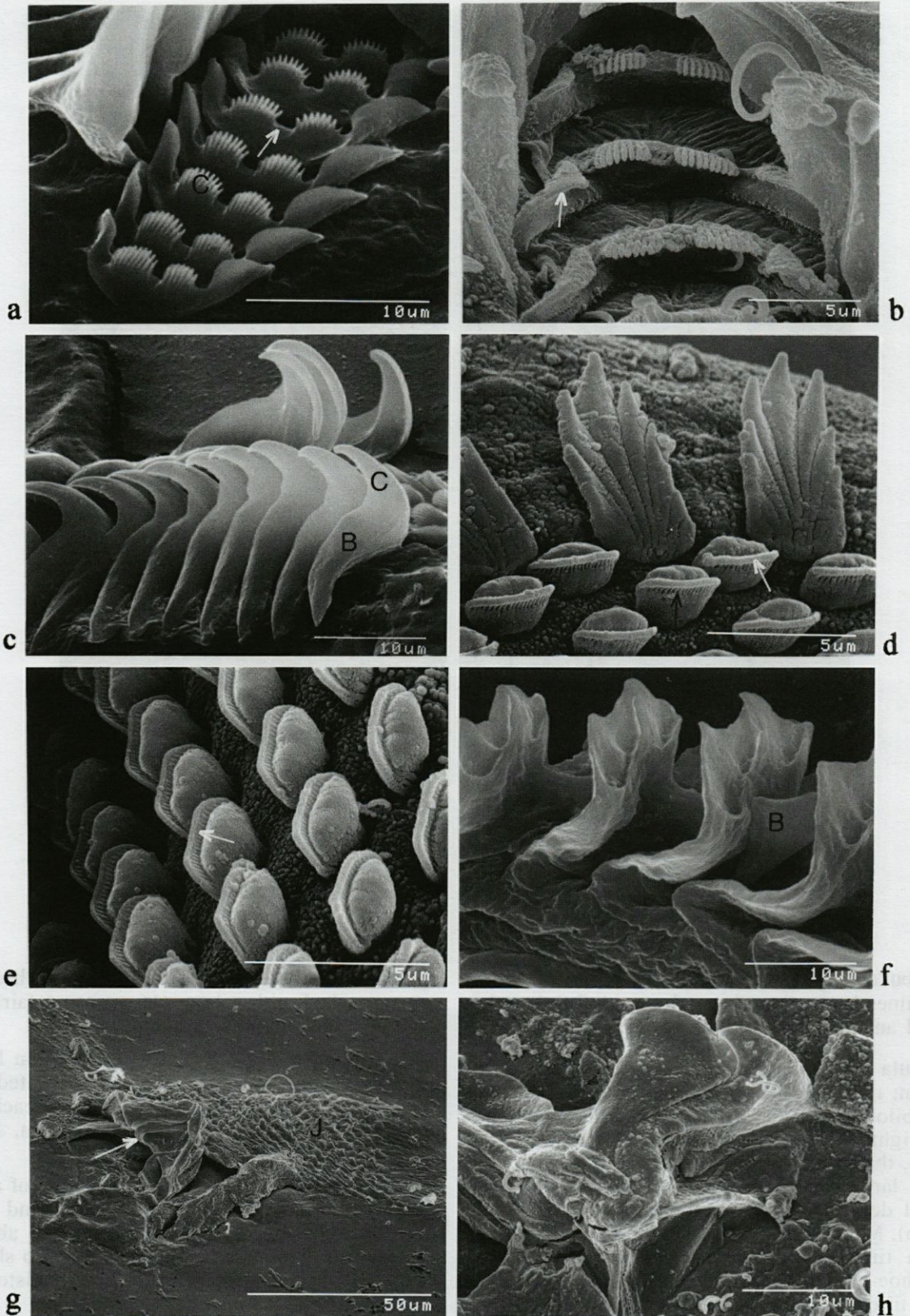
Radula (Pl. V a-c): $22 \times 1.1.1$ (spec. fix. 1.1 mm; rad. l. $130 \mu\text{m}$). Rachidian teeth ($15 \mu\text{m}$ wide) bilobed (Pl. V a, b), each pad with 6-10 slender, slightly diverging denticles of equal length ($2 \mu\text{m}$), their tips forming a slight arc, less curved on the larger teeth. Pads flatly *Cardium* shaped. Central depression deep and broad (up to $2 \mu\text{m}$; Pl. V b). Most teeth without central denticle, some with a tiny, triangular and pointed one. Bases horseshoe-shaped, sides ($10 \mu\text{m l.}$) rather high laterally, tilted inwards, their upper edges forming an-

gular lobes. Laterals (Pl. V c) smooth, blunt and swan-necked with a long ($16 \mu\text{m}$) and fairly high ($10 \mu\text{m}$) base without a hump.

4 triangular gizzard plates ($80-100 \mu\text{m l.}$) with one broad end and the other more pointed. They bear 8 lamellae (Pl. V f) with 1-3 tips each, their bases connected by a thick basal beam, leaving only one third of the tips free.

Male copulatory apparatus consisting of a short, wide penis, a cylindrical prostate gland and a seminal vesicle of variable size with abundant autosperm. No bursa has been found. No shell detectable by NaOH maceration nor in histological sections.

Plate V. – SEM micrographs. **a – f.** *Runcina langei* Schmekel & Cappellato n. sp.; **a**, radula; C one pad of a bilobed rachidian tooth, arrow: central depression; **b**, rachidian teeth; arrow: side of rachidian tooth tilted angularly inwards; **c**, lateral teeth; B base, C cusp; **d**, jaw plates with prongs, scales with unforked furrows (black arrow), side facing the stomach; white arrow: bulge; **e**, jaw scales with unforked furrows (arrow), side facing the mouth; **f**, detail of gizzard plate; B basal beam. **g, h.** *Runcina avellana* Schmekel & Cappellato n. sp. **g**, juvenile radula (arrow) and reverse side of jaws (J); **h**, juvenile radula, view from above.



Etymology. This species is named in honour of Mr. Joe Lange, University of Münster, Germany, for his masterly work at the SEM.

Discussion. For comparison with *R. kressae* Schmekel & Cappellato n. sp., see discussion there. *R. prasina* (Mörch, 1863), from the Antilles, which is light green, has its notum covered with dense, minute warts while in *R. langei* the notum is smooth. The Bermudan species *R. inconspicua* Verrill 1901-1902, with a dark green-brown notum and a thin orange margin, has a light green foot with an orange-violet, uniquely undulating margin. Such margins do not occur in *R. langei*. *R. australis* Burn, 1963 (p. 10-15, Figs 1-11), from New South Wales, a greenish-black species with an ashy-yellow margin, has a small inner shell and denticulate laterals. *R. langei* has no shell and smooth laterals. *R. adriatica* Thompson, 1980, from Rovinj, has circular, isolated black blotches often arranged in rows, while *R. langei* is covered with fine, diffuse olive-green specks, and three paired, marginal black marks at the notal margin. The scales of the jaws of both species bear grooves, but in *R. adriatica* (part II: Pl. IV c) the grooves are only on one side, in *R. langei* (Pl. V d, e) on both sides. The plates of the jaws of *R. adriatica* (part II, Pl. IV b) have blunt prongs – in *R. langei* (Pl. V d) they are more pointed. The body colour of *R. falciforme* Ortea, Rodríguez & Valdés, 1990, from Cape Verde Islands, is uniform, transparent green, while *R. langei* is covered with fine, olive green specks. The laterals of *R. falciforme* are denticulate, but smooth in *R. langei*, and the position of the genital pore is more adanal than in *R. langei*. *R. paupera* Ortea, Rodríguez & Valdés, 1990, also from Cape Verde Islands, like *R. langei*, has small black spots in the centre of the brownish-green notum. The authors did not mention any opaque white markings, abundantly present in *R. langei*. The teeth of the radula of *R. paupera* have twice the number of *R. langei* ($22 \times 1.1.1$). The cutting edge of the rachidians is straight and the laterals might have fine denticles (Ortea *et al.*, 1990, fig. 4 K, 4 L), in contrast to arced rachidian pads and smooth laterals in *R. langei*. The common genital aperture lies close to the anus only in *R. paupera*. The brown to olive-green *R. macrodenticulata* Garçia *et al.*, 1990, from Gibraltar, has longitudinal brown, olive green and yellowish-white bands on the head, whereas *R. langei* only has one white cross-band behind the eyes. The unique giant denticles of the lateral teeth separate it clearly from *R. langei*.

Runcina kressae Schmekel & Cappellato n. sp. (Pl. II g, III d, VI a-h; part II, Table I).

Banyuls: 3 specs. 0.7-2.0 mm l., Aug. 1986; 54 specs., 0.5-2.5 mm l.; 1994-1998, ca. 5-15 m depth, from rhizomes of *Posidonia*, *Zostera*, *Cymodocea* and small algae from Racou to Cap l'Abeille. Holotype and paratypes at Senckenberg Mus., Frankfurt, n° 322851, 322852.

Description of the living paratype (March 28, 1996, outside the Observatoire Arago at 5 m depth) of 1.8 mm l., 0.4 mm w., 0.3 mm h., tail 0.4 mm (holotype: Sept. 25, 1998, outside the Centre Hélio-Marin, 2 m depth; Pl. III d, fix. 0.9 mm h., 0.5 mm w., 0.3 mm h., tail 0.1 mm). Very agile, crawling quickly. Body shape elongated, flat, with a fairly pointed and slightly notched anterior region. In movement there are small head lobes. Rear of the smooth notum rounded and not raised. Foot as wide as notum, tail long, rounded. Eyes of medium size, close to and slightly lateral to the buccal mass. Common genital opening one third of the body length anterior to the median anus. Gills to the right of the anus, consisting of 2 rounded laminae, the larger and more ventral one subdivided into horizontal arcs, once dorsal and three times ventral, and the smaller one a simple lamina.

Ground colour yellowish. Brownish-greenish viscera visible through the ectoderm. Notum crossed by a broad band of tiny, opaque white, round spots a short distance behind the eyes. Notum rear opaque white with an almost straight anterior outline (Pl. III d). Scattered white spots on the notum, more concentrated along the median line of the body, and bordering the lateral notum rim, here interspersed with dark patches. Rounded to oval black patches of somewhat variable size border the white cross-band and the anterior outline of the white notum rear, thus forming three striking, black transverse lines (Pl. II g, III d). Black and white cross-bands slightly curved away from the front and continuing laterally down the notal furrow onto the foot. Foot sole uniformly yellowish-greenish without any dark patches. Tail with a few blackish-brown spots in its centre close to the body, and flanked by few small white spots. Colour varieties: the dark patches may form less distinct cross-bands but be partially scattered may be over the notum. Rarely do they form a fourth cross-band. The tiny white spots are dense, even partly obscuring the eyes. Sometimes the foot sole is sprinkled with white spots or may bear a few dark patches, often arranged in a cross line just anteriorly to the tail. The tail may lack dark patches completely or may have more patches or streaks.

Anatomy: Triangular jaws (Pl. VI e; spec. fix. 0.8 mm) with scales shaped like a closed shell. Edge of the scales a sharp rim (Pl. VI g), below it both sides with very fine and parallel, vertical, unforked grooves. On the side facing the gizzard they run down one quarter of the scale, on the side facing the mouth they do not exceed the horizontal furrow just below the rim (Pl. VI g; spec. fix. 0.6 mm). 6-7 plates ($4 \times 8 \mu\text{m}$, tips $2.5 \mu\text{m}$ l.) with 6-11 pointed prongs each (Pl. VI f; spec. fix. 0.8 mm), arranged close together, their size decreasing strongly towards the sides of each plate.

Radula (Pl. VI a-d): $25 \times 1.1.1$ (spec. fix. 1.8 mm; rad. l. $240 \mu\text{m}$). Rachidian teeth ($16 \mu\text{m}$ w.

in the 0.8 mm spec.) bilobed (Pl. VI c) with 10-14 dense denticles of nearly equal length (1.6 μm long, 0.4 μm l.) per pad, forming a slightly curved, flat comb. A broad (1.0 μm) and deep depression between the two pads. Of three examined radulae the rachidians of two lack a central denticle, in a third they bear a short one. The sides (13 μm l. in the 0.8 mm spec.) are relatively erect and hardly tilted inwards (Pl. VI d). The laterals (21 μm b. in a 1.8 mm spec.) are smooth, blunt and swan-necked, mostly without hump (Pl. VI a). There seems to be a distinct groove (Pl. VI b) along the backside of the cusp (19 μm h.).

4 gizzard plates (55 μm l., Pl. VI h) with 6 lamellae, each with 3 tips (spec. 0.8 mm). A beam connecting the bases of all lamellae leaves half of the lamellae free.

Male copulatory apparatus consisting of a short, wide penis, a cylindrical prostate gland and a seminal vesicle of variable size with a great amount of sperm. No bursa has been found. No shell detectable by NaOH maceration or in histological sections.

Etymology. This species is named in warm and thankful friendship to Dr. Annetrudi Kress, Basel, Switzerland, who provided us with many specimens of *Runcina coronata* (de Quatrefages, 1844) and *Runcina ferruginea* Kress, 1977 from Plymouth, GB.

Discussion. For comparison of this new species with *R. hansbechi* n. sp., and *R. banyulensis* n. sp., see discussions there. As there are certain external similarities between *R. langei* and *R. kressae*, these two species must be compared carefully. The body of *R. langei* is rounded with a rounded tail, while *R. kressae* is elongated with a pointed tail. *R. langei* has tiny olive green specks spread diffusely over the body and white spots only bordering the outline of the notum end. *R. kressae* has 3 striking black cross-bands and an opaque white half-moon on the notum rear, with a straight anterior border. The jaws of *R. langei* and *R. kressae* both have scales with grooves. But *R. langei* has a comfortable, smooth bulge (Pl. V d) along the rim – which is sharp in *R. kressae* (Pl. VI g). In *R. langei* the vertical grooves end below the bulge (Pl. V d), in *R. kressae* these grooves reach onto the rim of the scales itself (Pl. VI g). The sides of the rachidians are higher and less tilted inward in *R. kressae* than in *R. langei* (Pl. VI d, V b). The notum of *R. capreensis* Mazzarelli, 1894, from Capri, bears isolated, rounded black blotches spread evenly over the charcoal black notum but never arranged in cross-bands like in *R. kressae*. The circular, isolated black blotches in *R. adriatica* are spread evenly or filed up in longitudinal and transverse lines on the notum (Pl. II j, III e, f), whereas they form only three cross-bands in *R. kressae* (Pl. II g, III d). The scales of the jaws show striking differences. In *R. kressae* they have a sharp rim and grooves on both sides, in *R. adriatica* there is a

thick bulge along the rim, and grooves only on one side (part II, Pl. V c). The brown to olive green *R. macrodenticulata* Garçia *et al.* 1990, from Gibraltar, has longitudinal brown, olive green and yellowish-white bands on the head but no transverse bands like *R. kressae*. The laterals of *R. macrodenticulata* have giant denticles, but those of *R. kressae* are smooth. *R. paupera* Ortea, Rodríguez & Valdés, 1990, from Cape Verde Islands, exhibits diffuse black spots in the centre of the brownish-green notum. There are no opaque white spots or transverse bands such as in *R. kressae*. The radular formula is about twice the number of *R. kressae*. The laterals (Ortea *et al.* 1990, fig. 4L) seem to have fine denticles, but are smooth in *R. kressae*. The genital pore lies close to the anus only in *R. paupera*.

Runcina hansbechi Schmekel & Cappellato n. sp. (Pl. II c, III c, VII a-h; part II, Table I)

Material: 6 specs. 0.8-2.6 mm l.: 4 \times Sept. 1997, 2 \times Sept. 1998. Banyuls, collected by diving from *Posidonia* rhizomes at 8 m depth outside the Observatoire Arago and from rocks with algal growth near the surface near the Centre Hélio-Marin. Holotype at Senckenberg Mus., Frankfurt, N° 322853.

Description of the living holotype (March 30th, 1996; *Posidonia* rhizomes, 8 m depth outside the Observatoire Arago; Pl. III c) of 2.2 mm l., 0.6 mm w., and 0.4 mm h., tail 0.5 mm. Animal moderately agile. Body shape oval; smooth notum slightly notched anteriorly with distinct head lobes; rear slightly raised. Foot as wide as notum, tail fairly wide and rounded. Rather small eyes, relatively wide apart and difficult to distinguish among the colour pattern. Anus terminal and median, common genital opening anterior to the last third of the body. Two rounded gills, subdivided several times horizontally, to the right of the anus.

Ground colour of the body yellowish-beige. Viscera pale orange to brownish. Notum, notal furrow, foot, foot sole, and median region of the tail covered with large, amoeboid black blotches of variable shape and size (Pl. III c), often close to each other, sometimes even merging. The size of the blotches decreases towards the notal margin. On the foot sole they are less intensive but even larger than on the notum. On the upper foot they are more distinct again, resembling a string of pearls. The black blotches on the median of the tail lie within a broad band of dark brown pigment (Pl. II c). On the notum the spaces between the black blotches are covered with small, opaque white spots, thus giving the impression of sinuous lines and fields. The white spots are denser at the notal margin, with exception of the head. Sides of tail densely covered with white spots, less so the foot sole. Gills transparent with black pigment deep below the surface. Varieties: Two specimens from 09.1998 have very small white triangles behind the eyes on the sides of the head.

Plate VI. – SEM micrographs. *Runcina kressae* Schmekel & Cappellato n. sp.; **a**, radula; Ra rachidian teeth, L lateral teeth; **b**, lateral teeth with groove (G); **c**, rachidian teeth; arrow: broad central depression without central denticle; **d**, radula; arrow: erect sides of rachidian teeth; **e**, reverse side of jaws; S saucer shaped scales, P plates with prongs; **f**, protruded jaws (hyperthermic stress method), plates with prongs (bottom), scales (top); **g**, detail of 'f'; scales with unfurrowed furrows and sharp rim (R); black arrow: side facing the mouth, white arrow: side facing the stomach; **h**, gizzard plate.

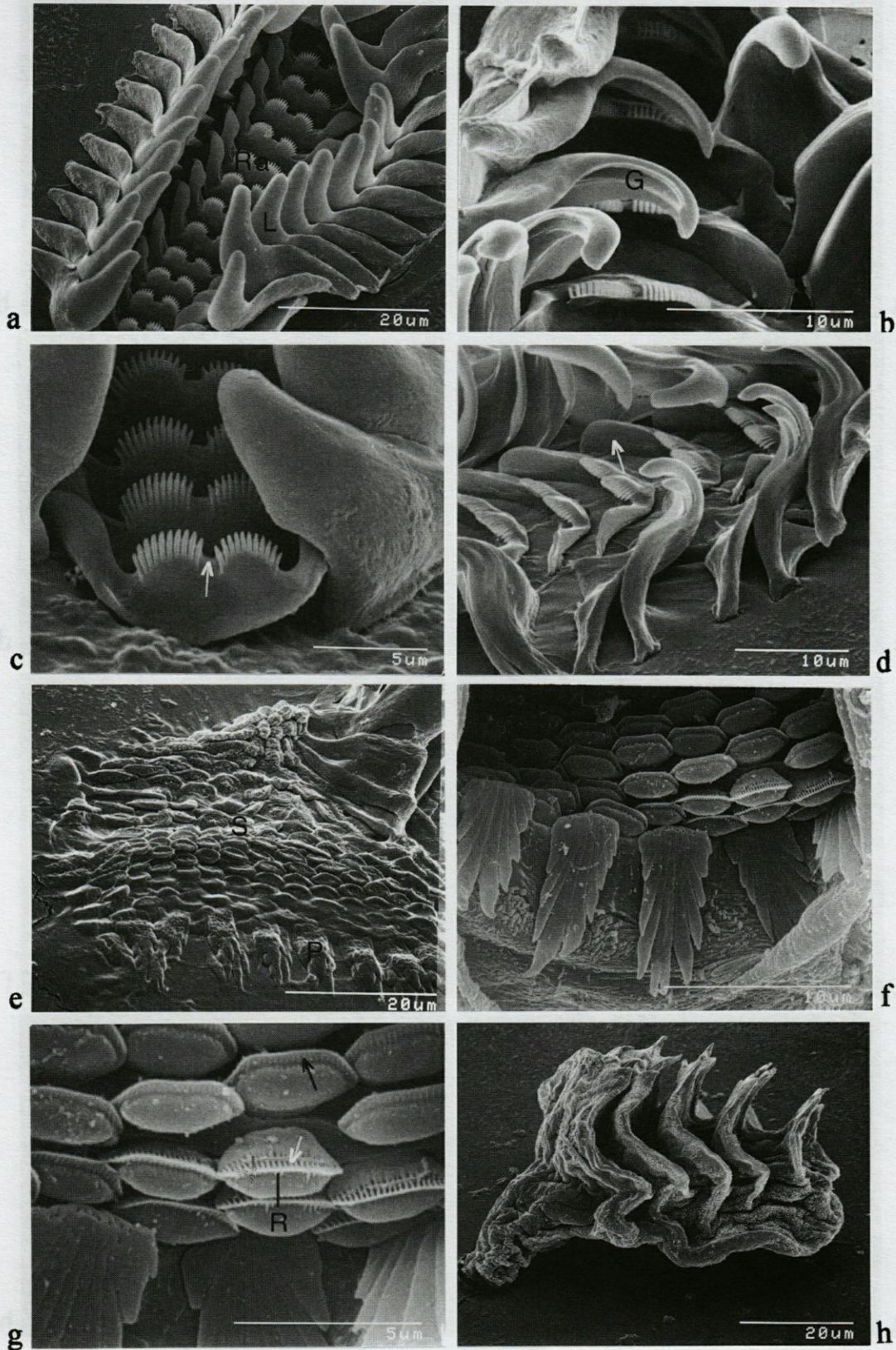
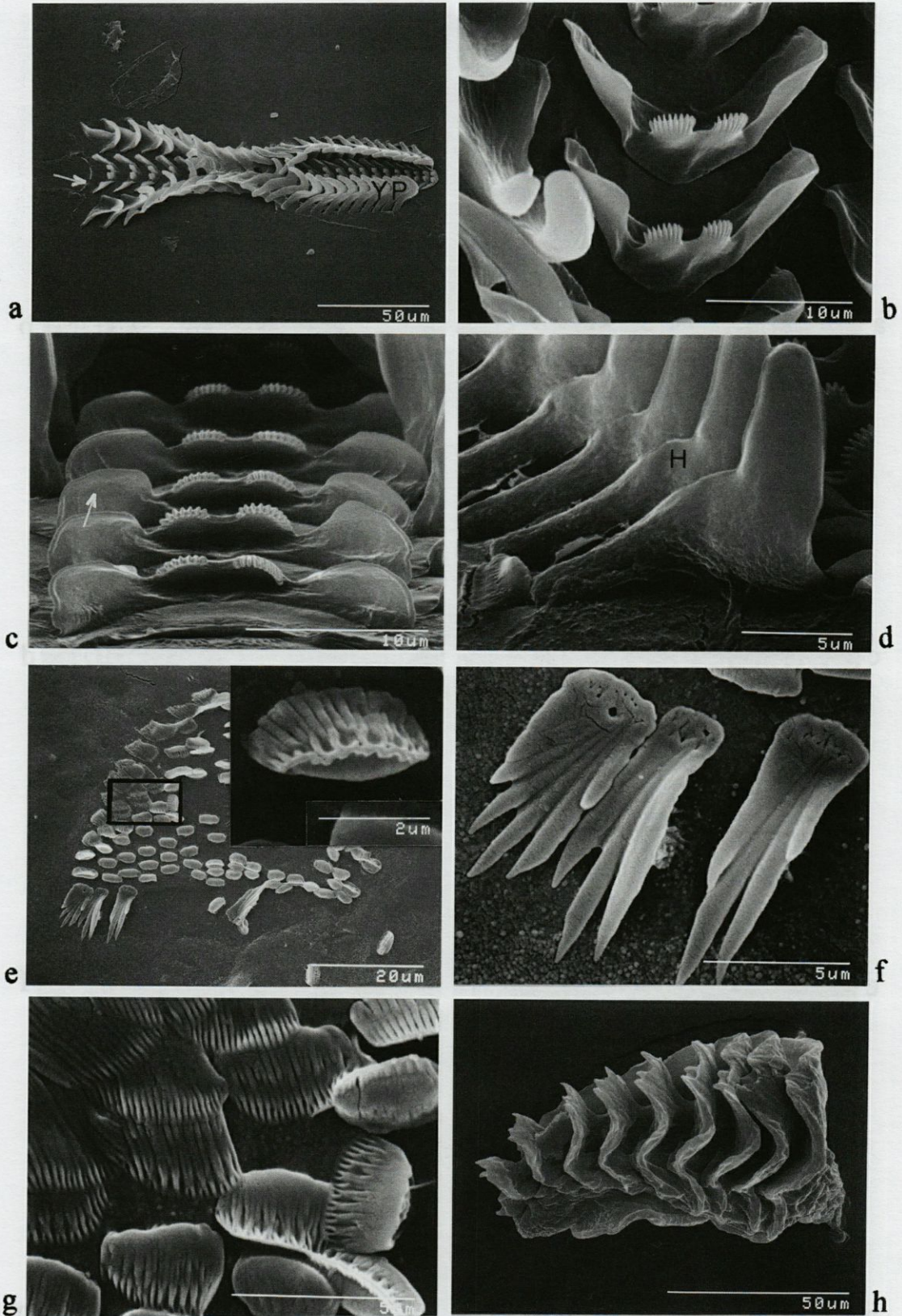


Plate VII. – SEM micrographs. *Runcina hansbechi* Schmekel & Cappellato n. sp.; **a**, total view of adult radula; YP youngest part, arrow: worn down group of teeth; **b**, rachidian teeth; arrow: triangular trough; **c**, rachidian teeth; arrow: erect sides; **d**, lateral teeth; H hump; **e**, jaws from the side of the oesophagus lumen, partially damaged; frame: see 'g'; inset: scale with forked furrows; **f**, plates with pointed prongs; note perforated bases; **g**, scales of 'e' with forked furrows and sharp rim; **h**, triangular gizzard plate.



Anatomy: Triangular jaws with scales (spec. fix. 1.7 mm; Pl. VII e). of very variable shape (Pl. VII e inset, g), with a sharp rim and vertical, often forked grooves (inset) on both sides. On the side facing the gizzard they cover one third of the scale, on the side facing the mouth they do not exceed the horizontal furrow just below the rim. The grooves are forked most on the scales at the margins of either field. 11-12 plates ($10 \times 3 \mu\text{m}$), each with 4-6 very long, pointed, parallel prongs, the largest in the middle of each plate (Pl. VII f). Bases of the plates with minute holes (Pl. VII f).

Radula: $23 \times 1.1.1$ (spec. fix. 1.7 mm, rad. l. $165 \mu\text{m}$; Pl. VII a). Rachidian teeth ($19 \mu\text{m}$ b., sides $12 \mu\text{m}$ l., $3.5 \mu\text{m}$ h., cusp $4 \mu\text{m}$ h.) bilobed (Pl. VII b), the 8-10 relatively short and pointed, diverging denticles of each flatly *Cardium*-shaped cusp forming a slight arc. A deep and broad depression between the pads, no central denticle. Sides very high like wings (Pl. VII c), tilted smoothly inwards. Smooth laterals (Pl. VII d) shaped like a straight duck-neck ($18 \mu\text{m}$ h.); cusps hollow with rounded tips. Bases ($18 \mu\text{m}$ l.) either with or without a hump.

4 triangular gizzard plates (Pl. VII h), $90 \mu\text{m}$ l., having 9 lamellae with 3 tips each. Basal beam thick, leaving half to two third of the lamellae free. No shell detectable by NaOH maceration or in histological sections.

Etymology: This species is named with loving memories for the late father of D. Cappellato, Dr. Hans Gert Bech.

Discussion. Among the "black" *Runcina* we differentiate between two basic patterns resulting in the impression of "black": 1. Yellowish ground colour covered by black patches (e.g. *R. hansbechi*, Pl. III c). 2. Dark ground colour with black patches like *R. capreensis*, *R. africana* and Gosliner's (1990) *R. adriatica*. There are several species having a yellowish ground colour with black blotches, but compared with *R. hansbechi* there are fundamental differences. For comparison of this new species with *R. banyulensis* n. sp., see discussion there. *R. kressae* has three cross-bands of rounded to oval black patches, an opaque white cross-band behind the eyes and a white notum rear. The body of *R. hansbechi* is covered all over with irregularly shaped black blotches, interspersed with small white spots. The scales of the jaws of *R. hansbechi* show grooves, which often fork (Pl. VII e inset, g), in *R. kressae* they never do so (Pl. VI g). The plates of the jaws of *R. kressae* (Pl. VI f) have shorter and less pointed prongs than those of *R. hansbechi* (Pl. VII f). *R. adriatica* Thompson, 1980 from Rovinj always has rounded, isolated black blotches often lined up in rows and a white cross-band and notum rear (Pl. III e, f), while in *R. hansbechi* the black blotches are variably amoeboid in shape and spread randomly, with white spots distributed evenly among them (Pl. III c). The scales of the jaws in *R.*

adriatica bear unforked vertical grooves only towards the gizzard, but in *R. hansbechi* the grooves are on both sides of the scales and forked (Pl. VII e inset, g). Very characteristic are also the thin, thorn-like, acutely pointed tips of the jaw-plates in *R. hansbechi*. In *R. hansbechi* the rachidians form much higher wings than in *R. adriatica*. *R. capreensis* Mazzarelli, 1894, never rediscovered: three animals have been found by Mazzarelli at 80 m depth at Capri. The body shape is rather similar to that of *R. hansbechi*. Both species have more or less distantly set black blotches, interspersed with white spots, but the ground colour of *R. capreensis* is charcoal black ("bistro") with a yellowish head, whereas the ground colour of *R. hansbechi* is yellowish. On the picture of Mazzarelli (1894; fig. 16) the black patches of *R. capreensis* are smaller, more circular and set more distantly than in *R. hansbechi* where they are variably amoeboid. *R. hansbechi* bears blackish blotches on the yellowish foot sole, Mazzarelli (1894: p. 4) does not mention any black blotches on the yellow foot sole. The rachidians of *R. capreensis*, according to Mazzarelli, resemble those of *Ildica nana* as described by Bergh (1889). *Ildica nana* has rachidians with one smooth and rounded central cusp bearing only one minute denticle on either side. *R. hansbechi* has classical bilobed rachidians with two denticulate cusps, instead.

***Runcina nivale* Schmekel & Cappellato n. sp.** (Pl. II e, IV a; part II, Table I)

Material: Naples, Ischia/Porto (Italy): 2 specs., Oct. 21st, 1967 from sand interstitium, 2 m depth, near the beach (loc. typ.). Due to the sampling method we have seen only the dead animals. Holotype and Paratype at Senckenberg Mus., Frankfurt, N° 322854.

Body shape of fixed holotype (2 mm l., 1 mm w., 0.7 mm h., tail 0.5 mm; Pl. IV) high and droplet-shaped, widest and highest at the notum rear. Front of smooth notum straight, almost no head lobes. Notum rear slightly bilobed (damaged and regenerated?). Foot sole slightly broader than notum; tail very long, broad and rounded. Very large and conspicuous eyes (Pl. IV a), just beneath the epithelium, and close to the anterior border. Anus terminal and median, very large gills to the right side of it, protruding from beneath the notum rear (Pl. IV a), and consisting of three laminae, all subdivided horizontally, up and down. They insert even more tilted than in other species of *Runcina*. Varieties: The smaller specimen (paratype, 1.4 mm l.) shows a pointed notum rear and three rounded and undivided gill laminae.

The species is totally whitish transparent, thus the viscera, ganglia and the oesophagus are visible. As a shell probably would be easily detectable due to the transparency of the animals, we conclude that there is none.

Discussion: This species is the only one of the few found in the sand interstitium, which is completely whitish and transparent (perhaps whitish when alive) with large gills and large eyes. Poizat (1978) described another species from the mesopsammnon near Marseille. He found a great number of dark *Runcina* (Pl. XII D) which he identified as *R. coronata* (see discussion *R. coronata*).

Runcina banyulensis Schmekel & Cappellato n. sp. (Pl. II i, IV f, VIII a-h; part II, Table I)

Material: 4 specs: 1 × 0.8 mm l., March 1996; Banyuls, near the Observatoire Arago, from *Posidonia* rhizomes by diving at 5 m depth. 3 × 1.2-1.4 mm l., Sept. 1997; from small rocks outside the Centre Héliomarin, 1.5-2 m depth; Holotype at Senckenberg Mus., Frankfurt, N° 322855.

Holotype (Sept. 26, 1997, Centre Hélio-Marin, Banyuls, 1.5 m; Pl. IV f) alive 1.2 mm l., 0.5 mm b., 0.3 mm h., tail 0.1 mm. Body shape elongated, scarcely with head lobes. Quick crawler, in movement even more elongated. Widest region of smooth notum behind the middle of the body length. Anterior notal border with a depression, notum rear long and rounded. Alive foot as wide as notum, after fixation foot slightly broader (Pl. IV f). Tail short and rounded. Characteristically large eyes (Pl. II i, IV f) close together, high below the epidermis, and close to the anterior notal border. Anus median and terminal, common genital orifice could not be discerned. One rounded gill lamina, slightly subdivided horizontally, just to the right of the anus.

Ground colour translucent yellowish to light beige, viscera beige to brown. Fine, sharp, isolated black specks (Pl. IV f) on notal surface and furrow, and scarcely scattered on the yellowish foot sole. Notum broadly bordered all around with opaque white spots, interspersed in the head region with some larger red-brown spots, and with red spots further down the body and at the rear. The red and red brown spots bleach quickly after fixation. Behind the eyes a broad opaque white cross-band, another longitudinal band runs along the median line, not reaching the notum rear. Together they form a pure white 'T' without red or brown spots. The posterior border of the cross-band is contoured with large black points. Varieties. Two specs. have a black mark on either side of the foot sole at the insertion of the tail. In the smallest specimen the median white line is absent and the white along the notal margin is less pronounced, but the large eyes are striking, too.

Anatomy: Reverse side of jaws shows triangular fields (90 µm, spec. 0.8 mm l., Pl. VIII f) with papillae (1 µm h.) and scales (max. 6 µm b.). 10 plates (9 × 4.5 µm), mostly with 4 pointed prongs (3 µm l., Pl. VIII g).

Radula formula 22 × 1.1.1 (130 µm l.; spec. 0.8 mm, Pl. VIII a, b). Rachidians (15 µm b., sides 12 µm l., 3 µm h.) bilobed, each flat pad with 8-9

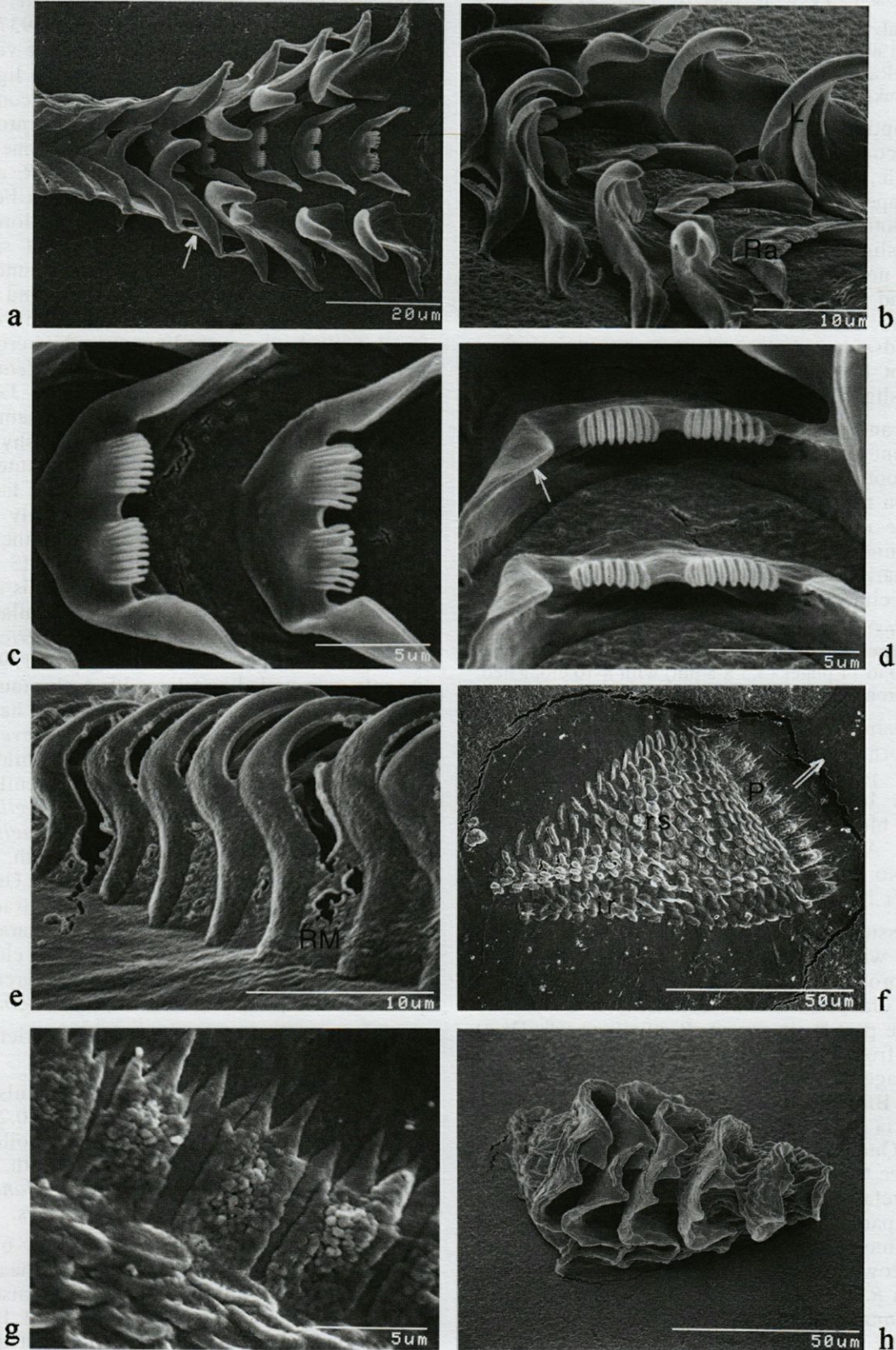
pointed, parallel denticles (2.5 µm l., l. 1.2 µm), more pointed and more diverging in the smaller teeth, and forming a slight arc. Central depression broad (1.2 µm), deep and concave, without central denticle (Pl. VIII c, d). Sides of moderate height, in the highest region tilted angularly inward (Pl. VIII d). Laterals (Pl. VIII b, e) smooth, blunt, swan-necked and without hump (18 µm l. × 15 µm h.). Cusps hollow (Pl. VIII b).

4 boat-shaped gizzard plates (80 µm long) with 1 × 4 and 3 × 6 lamellae (Pl. VIII h) with 2 or 3 tips each. Thick and broad basal beam, leaving half of the lamellae free. N° shell detectable by NaOH maceration or in histological sections.

Discussion. The most characteristic features of *R. banyulensis* are the large eyes, the fine black specks all over, and the red brown to red spots scattered within the opaque white margin of the notum. The black specks scattered on the notum are smaller than in most black spotted species (Pl. IV f).

R. kressae (Pl. III d) is yellowish with three cross lines composed of black spots. But in contrast to *R. kressae* with a narrow white border only laterally, alternating with black patches, *R. banyulensis* has a broad white border all around the notum, mostly interspersed with red or red-brown spots (Pl. II g, i), and no black spots in cross bands. The eyes of *R. banyulensis* are larger and lie higher beneath the epidermis. The arc of the pads in the rachidians of *R. banyulensis* is straighter than in *R. kressae*, their denticles seem to be shorter (Pl. VI c, VIII c). The body shape of *R. hansbechi* is more rounded compared to the slim *R. banyulensis*. In *R. hansbechi* notum and foot are covered with striking, large, amoeboidly shaped black blotches while *R. banyulensis* shows very fine black spots (Pl. III c, IV f). *R. hansbechi* has no opaque white cross-band behind the eyes and no white median line like *R. banyulensis*. While the eyes of *R. hansbechi* are small, they are particularly large in *R. banyulensis*. The radular formula of the two species is similar but the sides of the rachidians are more erect in *R. hansbechi* (Pl. VII c, VIII d). The laterals of *R. banyulensis* are slimmer and more swan-necked, and the gizzard plates have a higher basal beam than those of *R. hansbechi* (Pl. VIII h, VII h). *R. banyulensis* is elongated, in contrast to the squat *R. adriatica* Thompson, 1980 from Rovinj, with pronounced head lobes. The eyes are much larger and higher in *R. banyulensis*. *R. adriatica* has large, rounded, isolated black patches, often arranged in lines, while *R. banyulensis* bears fine sharp black points scattered over the body. Both species have a white cross-band (Pl. II f, j) and mostly a white median line, but only *R. banyulensis* has a broad opaque white notal margin all around. The plates of the jaws of *R. banyulensis* have max. 4 pointed prongs (Pl. VIII g), *R. adriatica* up to 9 blunt prongs (part II, Pl. IV b). The denticles of the rachidians of *R.*

Plate VIII. – SEM micrographs. *Runcina banyulensis* Schmekel & Cappellato n. sp.: **a**, radula; arrow: radular membrane; **b**, radula; Ra rachidian teeth, L lateral teeth; **c**, rachidian teeth; **d**, rachidian teeth with sides tilted inwards (arrow); **e**, lateral teeth; RM radular membrane; **f**, opposite fields of jaws; double arrow: direction to the mouth, rs reverse side, ir imprint of right side through chitinous oesophageal lining, P plates with prongs; **g**, plates with paired prongs, reverse side; **h**, triangular gizzard plate.



banyulensis (Pl. VIII c) do not have an isolated most exterior denticle like those of *R. adriatica* (part II, Pl. IV a).

Runcina avellana Schmekel & Cappellato n. sp. (Pl. II h, V c, IV g, h; part II, Table I)

Material: 3 specs. 1.0, 1.2, 1.5 mm l. Oct. 03, 1995, dredged at night at 5 m depth from *Posidonia* rhizomes, Banyuls, Racou (loc. typ.). Holotype at Senckenberg Mus., Frankfurt, N° 3222856.

Description of the living holotype (Pl. IV c) from Racou, 5m depth: 1.2 mm l., 0.3 mm w., 0.2 mm h., tail 0.3 mm. Very inactive and slow. Body shape very elongated oval and slightly convex, smooth notum almost without head lobes, anteriorly slightly notched, rear short and slightly pointed, not raised. Foot as wide as notum, tail broad and rounded. Small eyes, very deep and close to the front at the inner border of the translucent head sides. Anus and common genital pore could not be detected. One simple rounded gill lamina, slightly to the right of the median line.

Front and sides of the head and tail clear and translucent (Pl. IV c). Notum uniformly chocolate brown, foot sole lighter. Sparse, tiny, opaque white specks on the notum, mainly around the eyes and along the notal margin. No opaque white cross-band behind the eyes. One single round, blackish-brown mark on the centre of the tail (Pl. II h) in all three specimens!

Anatomy: Reverse side of jaws (Pl. V g) of the 1.2 mm spec. set with cup-shaped scales (3.5-10 µm diameter). 10 to 11 plates (3.5 × 8 µm) with 8-10 elongated, pointed prongs (1.8 µm l.).

Surprising for a *Runcina* of 1.2 mm l. is the radula formula $3 \times 1.0.1$ (Pl. V g, h), therefore a probably juvenile radula (see discussion of *R. setoensis* below). Smooth laterals with a high (19 µm), blunt and triangular cusp and a short base (11 µm). After preparation they are clustered together. No gizzard plates and no shell were recovered after NaOH maceration.

Discussion. This is the only chocolate brown *Runcina* with an opaque white sprinkling and a central brown mark on the tail. For comparison with the orange *R. hornae* Schmekel & Cappellato n. sp. see part II (in press). *R. avellana* (Pl. IV c) differs from brownish, juvenile *R. coronata* (Quatrefages, 1844; description in part II, Pl. III), from the Bretagne (compare *R. aurata* from Gibraltar: García *et al.* 1986, and Gosliner, 1990), and *R. ornata* (Quatrefages, 1844), in the elongated body shape (see Cervera *et al.* 1991; p. 200-201, Fig. 2). In Quatrefages' two species it is more oval and convex (part II, Pl. III a). They show distinct head lobes, almost absent in *R. avellana*. Both have at least yellow head sides, which are colourless transparent in *R. avellana* (Pl. IV c). The notum rear of *R. coronata* is cadmium yellow, in *R. ornata* asymmetrically yellowish only on the right side, but

chocolate brown in *R. avellana* (comp. García *et al.* 1986, p. 458-461, Fig 1-4; Cervera *et al.* 1991). In *R. avellana* we found a presumably juvenile radula ($3 \times 1.0.1$) with smooth laterals, so comparison with the adult radulae of the above species with denticulate rachidians and denticulate laterals is inappropriate. *Runcinida elioti* (Baba, 1937), from Oniike, Japan, is dark brown, inclined to yellowish green towards the margin. There are no light head sides like in *R. avellana* and the gill consists of several plumes arranged in a semicircle around the anus, while in *R. avellana* there is one simple rounded lamina slightly to the right. *R. avellana* (Pl. IV c) resembles *R. africana* Pruvot-Fol, 1953 (description in part II, Pl. I f), from Morocco, in the ground colour and the light head sides. *R. avellana* has opaque white spots surrounding the eyes, which are absent in *R. africana*, and a single black spot in the middle of the tail. Additionally *R. avellana* lacks the curved opaque white cross-band behind the eyes of *R. africana*. *Metaruncina setoensis* (Baba, 1954) from Seto, Japan, is blackish with a lighter foot sole, thus resembling *R. avellana*, but its mantle shows an ashy yellow submargin and a sprinkling with minute brown spots. *M. setoensis* has an internal shell, lacking in our species. Baba's species has a greatly reduced radula, not filed up in distinct rows. In the one examined *R. avellana* we found a radula ($3 \times 1.0.1$) arranged in rows. We cannot judge if this radula is juvenile or reduced. It looks very similar to the other juvenile radula found by us (*R. africana*). *R. lenticula* Gofas, Ortea & Rodríguez, 1991, from Angola, a rounded species with a chestnut notum and green flanks and foot, has no light head front and sides and no opaque white like *R. avellana*. It has very characteristic rachidians, not bilobed but with only one central denticle. The juvenile radula of *R. avellana* has no rachidians. *R. avellana* differs from the uniformly brown *R. ferruginea* (description part II, Pl. I a) from Plymouth, Thompson's *R. zavodniki* from Rovinj, and Gosliner's (1991) *R. spec.* from the Azores by its transparent head sides, its white specks and the characteristic single blackish-brown mark on the clear tail. Opaque white and colourless transparent body parts are completely absent in *R. ferruginea*.

Description of a special colour variety of *R. avellana*:

On March 31, 1996 we found at Banyuls a beautiful animal of 1 mm l. × 0.3 mm w. × 0.2 mm h., tail 0.2 mm, from *Posidonia* rhizomes collected by diving near Cap d'Abeille at 8 m depth. We describe it as a colour variety of *R. avellana*, but it may as well be yet another new species.

Body shape very elongated and flatly oval. Anterior notal border straight with small head lobes, posterior end slightly pointed and not raised. Foot as wide as notum, tail short and rounded. Eyes medium sized, close to the buccal mass at the inner

border of the yellow head sides. No anus or common genital orifice could be found. One small, rounded, undivided gill lamina to the right of the median.

Body dark velvet green. Notal margin, foot, gill and tail transparent lemon yellow, wider at anterior notal border and head sides; foot sole with a tinge of brown. A triangular, dark green blotch on either side of the insertion of the tail on the upper foot sole, another small round one in the centre of the tail. Posterior notum end bordered narrowly by dense, small opaque white spots. Animal sparsely covered with tiny white specks and tiny brown specks, somewhat more concentrated along the margins of notum and upper foot, and posterior from the dark marks at the tail.

This dark green animal looks similar to the brown *R. avellana* in body shape and distribution of colour, with some differences: the body shape of *R. avellana* is slightly convex, the green specimen is flatter. *R. avellana* is dark brown with only a single round, blackish-brown mark in the centre of the tail. The single specimen reported here is dark green with translucent yellowish margins and two dark green lateral triangular marks plus a round central one on the tail. This animal externally resembles *R. australis* (Burn, 1963: p. 10-15, Fig. 1-11), a greenish-black species with an ashy-yellow margin, a small inner shell and denticulate laterals. The body of *R. australis* is highly arched, without fine brown or white specks, bearing a small, ashy-yellow triangular patch at the notum rear above the shell. The specimen reported here is elongated oval and flat, its dark green body covered with fine brown and sparse white specks, but without a yellowish patch at the notum rear.

(1) Part of the thesis of the junior author, D. Cappellato.

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