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CLASS THECOSTRACA

SUBCLASS CIRRIPEDIA

SUPERORDER ACROTHORACICA

## Orders Lithoglyptida & Cryptophialida

Gregory A. Kolbasov

White Sea Biological Station, Biological Faculty, Moscow State University,  
119991, Moscow, Russia [gakolbasov@gmail.com](mailto:gakolbasov@gmail.com)

### 1. Brief characterization of the group and main diagnostic characters

The Acrothoracica is a group of small, burrowing, epibiontic barnacles found largely in carbonate sediments and skeletons of marine invertebrates, such as mollusc, corals, thoracican barnacles and bryozoans. The acrothoracicans are dioecious, with suspension-feeding females bearing dwarf males attached externally to the mantle sac. Females lack calcareous plates and live inside burrows (Tomlinson, 1969; Kolbasov, 2009). Currently the acrothoracicans encompass approximately 70 species assigned to 11 genera, 3 families and 2 orders, Lithoglyptida and Cryptophialida (Kolbasov, 2009).

#### 1.1. Morphology

The body proper of females is embedded in a **mantle sac** (Fig. 1, 2) attached to the substratum by the base (**attachment disk**). The external surface of the mantle sac is covered by setae, denticles, teeth and multifid ctenoid scales. The opening or **aperture** of the mantle sac is guarded by a pair of chitinous **opercular bars**, which in some species are equipped with setae, spines, teeth or large spine-like posterior processes. Some of the species have a globular or drop shaped **orificial knob** anteriorly to the opercular bars. The posterior halves of the opercular bars have underlying setose **comb collar**. The body proper of females of acrothoracican barnacles composed of **mouth appendages (trophi)** forming a mouth cone, 1 pair of short **mouth cirri** associated with mouth cone but reduced in order Cryptophialida, and a cluster of 3-5 pairs of long setose **terminal cirri** on elongated thorax, depending on the genus of the species (Fig. 1). Most females of the acrothoracican barnacles have biramus mouth and terminal cirri but species of the family Trypetesidae have 3 pairs of short uniramous terminal cirri. Most of species of the family Lithoglyptidae have a pair of **caudal appendages** behind the last pairs of terminal cirri.

Caudal appendages are absent in species of the lithoglyptid genus *Berndtia*, Trypetesidae and Cryptophialida. Mouth cone of the acrothoracican barnacles is composed of a single **labrum** and paired of **mandibles** with **mandibular palp**, **maxillules** and **maxillae**. Ventral side of the thorax of some species has conical processes. Most of the acrothoracicans are characterized with a gut and anus, but Trypetesidae have an incomplete gut which without anus (Tomlinson, 1969). The **dwarf males** of all acrothoracicans consist of a simple pear-, tadpole-shaped or lobed sac containing some inclusions, a testis and sometimes a penis, and the antennules by which they attach to the burrow or near the attachment disk of female (Fig. 2).

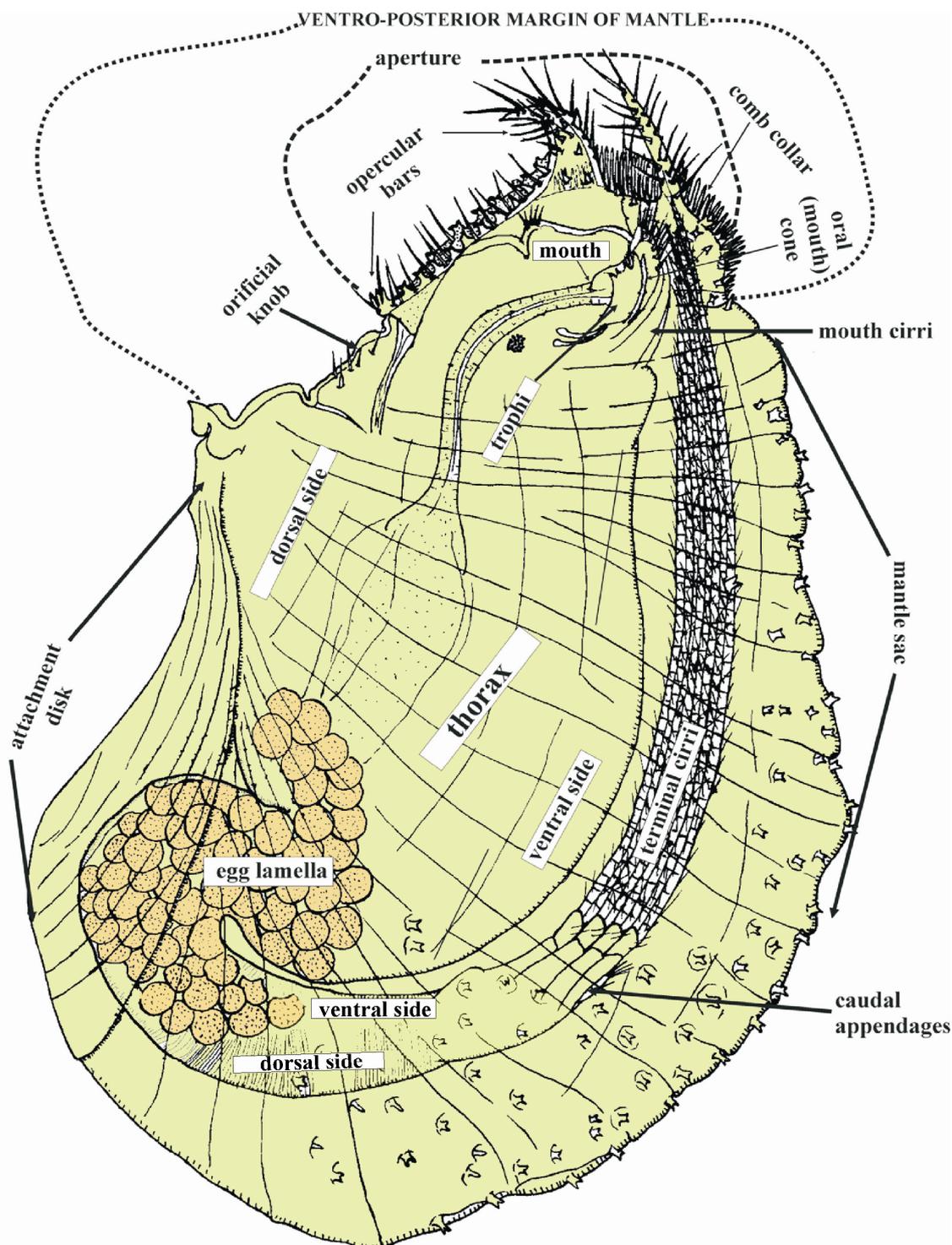


Fig. 1. Acrothoracica.

## 1.2. Natural history

Most of the species of the Acrothoracica are borers in mollusc shells, corals and calcite substratum. The specimens of the same species collected from different substrates do not exhibit any morphological differentiation, and molecular divergence in the COI and 16S (Chan *et al.*, 2013). Thus most of the acrothoracicans do not have any host specificity on their substratum selection and are abundant on a wide range of calcareous substrates. But in the coral reef system, the genus *Berndtia* are exclusive coral borers. *Berndtia* species appear to exhibit high degree of host specificity to their coral hosts (Chan *et al.*, 2014a). Species of the family Trypetesidae are detritivores, boring in the columella of the gastropod shells occupied by hermit crabs but recent data indicated that they also can feed on the eggs of hermit crabs (Williams *et al.*, 2011).

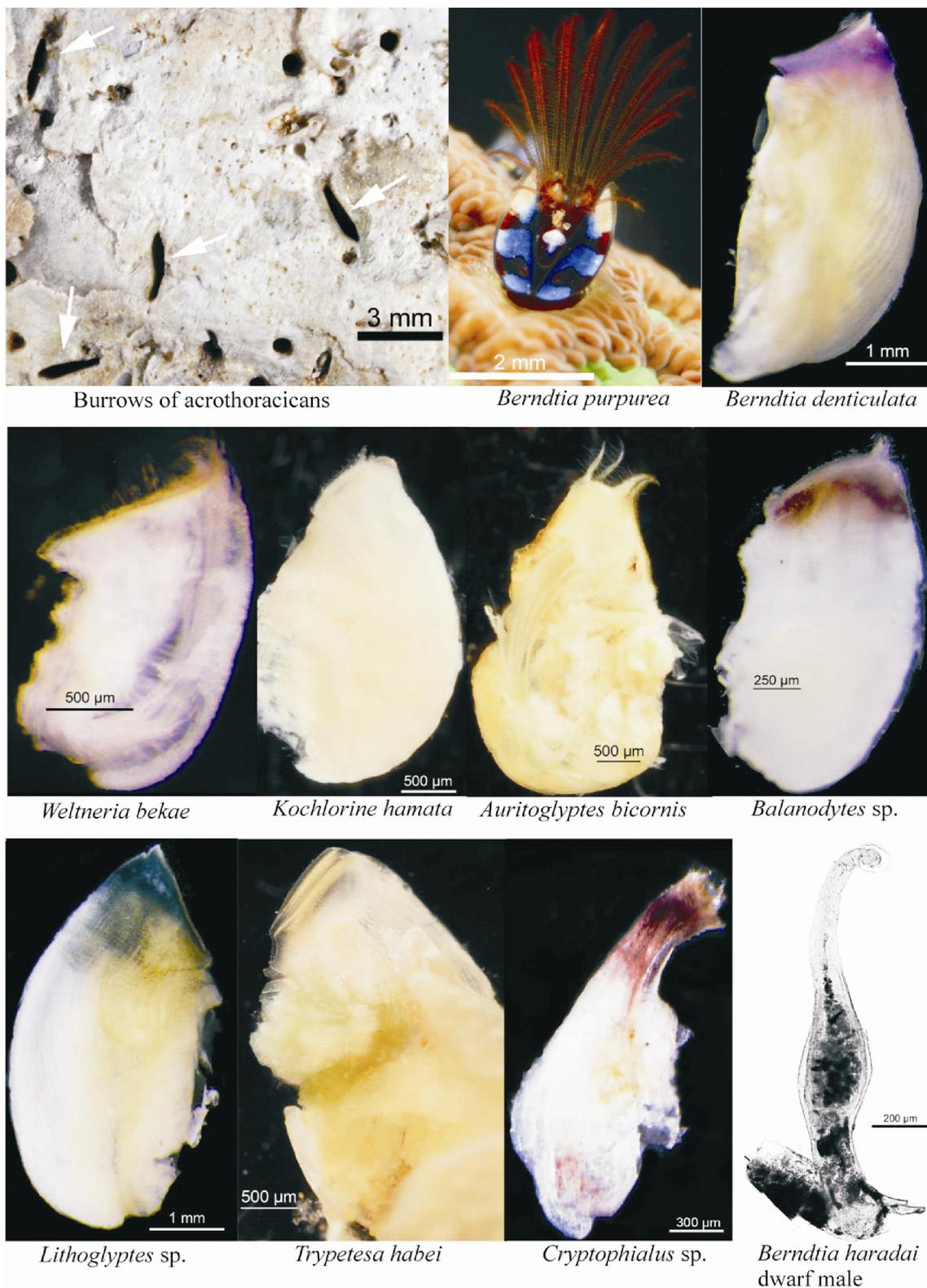


Fig. 2. Diversity of acrothoracins.

At least four free-swimming naupliar stages were found for several species of the order Lithoglyptida: genera *Berndtia*, *Balanodytes*, *Lithoglyptes* and *Trypetesa* (Kolbasov *et al.*, 2014). Nauplii of acrothoracins can be planktotrophic or lecithotrophic. Whereas most acrothoracins, including order Cryptophialida, are supposed to have brooded nauplii and only the cypris larva or 'cypris' is released (Kolbasov *et al.*, 1999; Kolbasov, 2009). All the acrothoracins possess a free-swimming cypris for substrate searching and settlement. Free-swimming nauplii of the acrothoracian barnacles have developed head shield with long frontolateral horns and long dorsocaudal spine. Body proper of cypris larva bears four-segmented antennules anteriorly, a pair of compound eyes with associated frontal filaments lies in

front of big, lobed cement gland in middle. Cypris larvae of the orders Lithoglyptida and Cryptophialida differ significantly in their morphology. The lithoglyptids have typical spindle-shaped cirripede cypris larvae with a well developed carapace that completely encloses the body and developed thorax with 6 pairs of natatory thoracopods. The cypris larvae of the Cryptophialida have a much smaller carapace, leaving parts of the body directly exposed, the thorax and thoracopods are rudimentary and not suitable for swimming and can only disperse by antennular walking resulting in highly gregarious populations of adults (Kolbasov & Høeg, 2007).

Three of five species known for the Iberia and Macronesia are endemics found from a single location. These are *Weltneria zibrowii* Turquier 1985 off Algeria, 20 m, in bryozoan *Myriapora truncata*; *Balanodytes stirni* (Turquier 1987) off Gibraltar, 90-390 m, in corals *Caryophyllia cyathus*, *Errina asperta*, *Lophelia pertusa*, *Madrepora oculata*, *Paracyathus pulchellus* and *Australophialus pecorus* Turquier 1985 off Gibraltar, 90-390 m, in corals *Caryophyllia cyathus*, *Errina asperta*, *Madrepora oculata*. Two acrothoracican species found in adjacent waters are also endemics. These are deep water *Weltneria exargilla* Newman 1974 from Bay of Biscay (47°50.7'N, 08°05.7'W), 1500 m, in lumps of clayey mud and tidal *Kochlorine gerebelnii* Kolbasov 2002 from Cape Verde Islands, in corals *Prionastera* sp.

### 1.3. Distribution

The acrothoracicans are cosmopolitan and were first discovered at relatively high latitudes, but their greatest diversity is found in the tropical seas of the world (Kolbasov, 2009). The acrothoracicans are abundant in coral reefs of West and Central Pacific where they may find a calcareous substrate for burrowing. They are also numerous in coral reef communities of Indian Ocean (the Red Sea, Aden Gulf) and West Indies. Five of 70 known species of the Acrothoracica inhabit Ibero-Macronesian area, 2 of them are widespread (*Kochlorine hamata* Noll 1872 and *Trypetesa lampas* (Hancock, 1849) and 3 species, as indicated earlier, are endemics of this area. Also two acrothoracican species from adjacent waters (*Weltneria exargilla* and *Kochlorine grebelnii*) may be found in studied Ibero-Macronesian area.

Although the Acrothoracica occur from the tidal to the middle bathyal (1000-1500 m), the majority of them inhabit the upper subtidal (0-30 m) and tidal zones.

### 1.4. General or applied interest

The Acrothoracica are the most primitive barnacles and have a great value in reconstruction of barnacle phylogeny and evolution.

### 1.5. Main diagnostic characters

The Acrothoracica are divided into two orders, the Lithoglyptida and the Cryptophialida (Fig. 3). The Lithoglyptida consists of the families Lithoglyptidae and Trypetesidae, which the females are characterized by having a wide aperture, a large saddle-like labrum, well-developed mouth cirri and absence of special gastric mill at the anterior end of the stomach. The Lithoglyptidae have biramous terminal cirri and an anus, whereas Trypetesidae have uniramous terminal cirri and lack anus. The females of the Cryptophialida have a narrow-necked operculum and a narrow crown-shaped aperture, an elongated, tongueshaped labrum, reduced mouth cirri and a special gastric mill at the anterior end of the stomach. The order Cryptophialida consists of the monotypic family Cryptophialidae.

## 2. Systematics of the group

The systematics of the Acrothoracica has been thoroughly studied (Tomlinson, 1969; Kolbasov & Newman, 2005; Kolbasov, 2009). The superorder Acrothoracica includes two orders Lithoglyptida with two families Lithoglyptidae and Trypetesidae, 9 genera and 49 species and Cryptophialida with the monotypic family Cryptophialidae, 2 genera (*Australophialus* and *Cryptophialus*) and 21 species. The Lithoglyptidae consists of three subfamilies, the Berndtinae (*Berndtia*, *Weltneria*), the Lithoglyptinae (*Lithoglyptes*, *Auritoglyptes*, *Balanodytes*) and the Kochlorininae (*Kochlorine* and *Kochlorinopsis*). The family Trypetesidae is monotypic and consists of 2 genera (*Tomlinsonia* and *Trypetesa*).

In Ibero-Macronesian region all five species of Acrothoracica were found off Iberian Peninsula: family Lithoglyptidae (*Weltneria zibrowii*, *Balanodytes stirni* and *Kochlorine hamata*), family Trypetesidae (*Trypetesa lampas*) and family Cryptophialidae (*Australophialus pecorus*).

## 3. Diversity of the group

The Ibero-Macronesian acrothoracicans compose only 7% of the World diversity. But only 2 species were found in other areas of the Mediterranean (*Kochlorine hamata* and *Trypetesa lampas*) and 3 species for North-East Atlantic from South France to Norway (*Weltneria exargilla*, *Trypetesa lampas* and *Trypetesa nassarioides*).

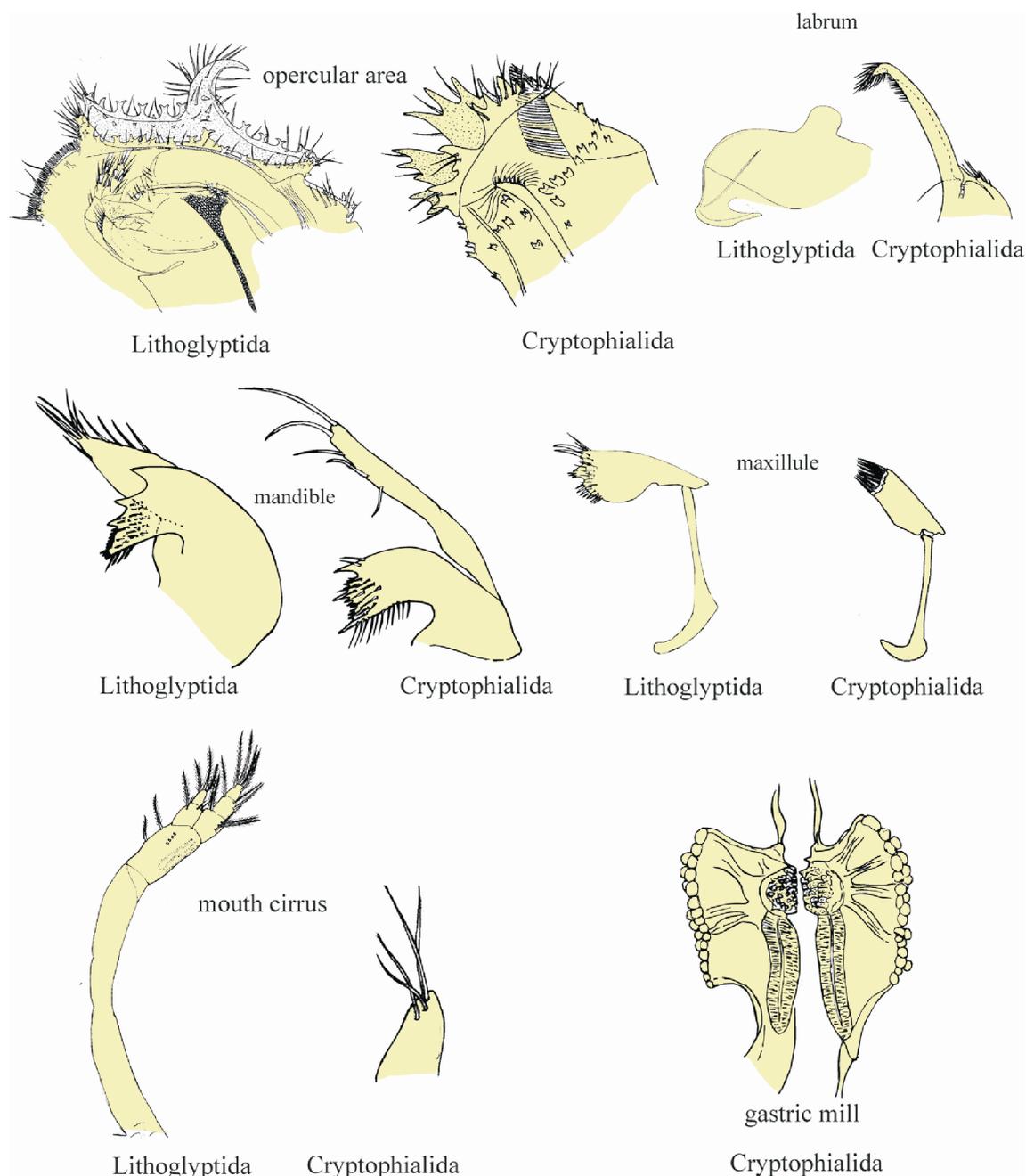


Fig. 3. Differences between Lithoglyptida y Cryptophialida.

#### 4. Current state of f the knowledge of the group

The tidal and subtidal marine communities of North-East Atlantic and Mediterranean are well studied. But only a few species of mostly tropical Acrothoracica have penetrated in these temperate and subtropical waters. Two monographs on the Acrothoracica concerning almost all aspects of their biology, including adult and larval morphology, anatomy, evolution and phylogeny, taxonomy and distribution were published (Tomlinson, 1969; Kolbasov, 2009). The new species may come from the deep waters of Ibero-Macaronesian area. It is not surprising that two of three endemic Iberian acrothoracicans were found in bathyal corals (Turquier, 1985a, 1985b, 1987).

#### 5. Main available sources of information

Two monographs (Tomlinson, 1969; Kolbasov, 2009), mentioned earlier, represent the main sources of information about the Acrothoracica. They contain descriptions and keys for all known acrothoracican species, including those inhabit Ibero-Macaronesian area. Recently a new well illustrated monograph on the Acrothoracica of Taiwan and adjacent waters was published (Chan *et al.*, 2014b). It contains data on morphology, life circle, host specificity and taxonomy of the Acrothoracica, as well as descriptions and key for 18 acrothoracican species from Taiwanese and surrounding Asian waters.

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