STEREOSCAN ELECTRON MICROSCOPE OBSERVATIONS ON
OPISTHOBRANCH RADULAE AND SHELL-SCULPTURE

by

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Traditional methods of observation applied to the
sculpture of teetibranch shells and to the radulae of
gastropods in general, have yielded a great deal of
information regarding the structure of these organs,
which are so important in taxonomy. In the genus
Philina, for instance, the numerous European species
of can be reliably distinguished only by means of radular
formula and shell-sculpture. In other genera the
structure of these organs is also of crucial importance
for identification. In most opisthobranch families the
structure of the radular teeth is a uniquely reliable
feature.

Published descriptions of shell-sculpture in opistho-
branchs have, however, not hitherto passed the hand-
d lens level of accuracy. The radula is customarily
prepared for microscopic examination (following dissec-
tion, and cleaning in hot caustic soda or potash) by
staining and mounting in balsam, or, more recently,
in polyvinyl lactophenol (Thompson, 1958). These
methods for the radula have the great disadvantage
that it is necessary to squash the preparation con-
siderably in order to examine the teeth. The results
of squashing are somewhat unpredictable and, more-
over, may distort or alter the natural relationships
of the teeth, rendering difficult a functional interpreta-
tion of radular morphology.

The stereoscan electron microscope is a new tool
for the investigation of shell and radular surface
structure. With this microscope these organs can be
examined and photographed, without elaborate pre-
liminary preparation, without squashing or fragmenta-
tion, and with a depth of focus which the light
microscope cannot attain. This is achieved within a
great range of magnification, from ×20 to ×100,000;
but it is in the lower part of this range that the value
of the instrument is particularly relevant in studies
of molluscan hard parts. It should not be assumed
that, because this microscope is an expensive and
relatively inaccessible piece of apparatus, it is value-
less in routine identification of gastropods. Indeed,
its chief value is that it enables so clear a picture of
the shell sculpture or radular morphology to be ob-
tained that more mundane methods of routine in-
vestigation are subsequently enlightened. The stere-
scan microscope shows clearly features which are
then easier to discern and understand with the hand-
d lens in the field.

Material for the stereoscan microscope is first
dried, then coated with a thin layer of gold-palla-
dium alloy. Direct observation is then possible, and
suitable representative areas can be selected for
photography. Photographic prints showing shell or
radular surface morphology can be obtained the same
day as the specimen was collected and killed, but
long-dead specimen are equally suitable. Some of
the photographs presented in Plate I were from
material deposited in the British Museum (Natural
History) over a century ago. The specimens are in
no way damaged by the technique and may be pre-
served in spirit or formalin after examination.

The micrographs were taken with a stereoscan
electron microscope produced by the Cambridge In-
strument Company and purchased for Professor Hint-
on with a grant from the Science Research Council.

REFERENCES

THOMPSON, T. E., 1958: Observations on the radula of
Adalaria proxima (A.&H.) (Gastropoda Opisthobran-
Plate I. Shell-sculpture in Philine.

A. Philine catena (Montagu, 1803), shell-length 4½ mm, “Porcupine” collection, British Museum (N.H.) reg. no. 1885.11.5.4100. In this species chains of linked oval areas on the outside of the shell give specimens a delicate lacework appearance. The chains form spiralling rows, approximately 10 per mm.

B. P. punctata (Adams, 1800), shell-length 2 mm, Torbay, English Channel, British Museum (N.H.) reg.no. 1967551/1. The sculpture consists of spiral rows (approximately 16 per mm) of oval dots, which are usually separate from one another, as shown here, but occasionally fused in some areas of the shell.

C. P. pruinosa (Clark, 1827), shell-length 4½ mm, Loch Fyne, British Museum (N.H.) reg.no. 1851.1.15.87. The sculpture consists of spiral and longitudinal rows of raised dots (approximately 20 rows per mm), which show a tendency towards fusion, varying in different individuals and on different parts of the shell. In some areas the dots run together to form raised lines.

D. P. scabra (Müller, 1776), shell-length 4½ mm, Cullercoats, Northumberland. The sculpture consists of spiral rows (approximately 12 per mm) of tiny oval dots; each dot consists of a raised oval platform, surrounded by a depressed “moat”. Where one “moat” joins the next, a tiny kidney-shaped structure is placed, and the whole effect is very chain-like. At the anterior border of the outer lip of the shell the chain-like striae may, in some specimens, project irregularly in saw-tooth fashion.

E, as for C, but at a slightly lower magnification.

F. P. quadrata (Wood, 1839), shell-length 4 mm, Aberdeen, Scotland, British Museum (N.H.) reg.no. 1967552. The sculpture consists of spiral rows (approximately 20 per mm) of small indentations, linked together in a chain-like manner. Sometimes the rows of dots are alternately wide and narrow, as shown in this micrograph, but this is by no means always the case.
Plate II. Radulae of eolid nudibranchs.
A-C, *Aeolidia papillosa* (L., 1758), adult specimen from Falmouth, Cornwall, radular formula 25x0.1.0. In this species, which feeds upon sea-anemones, each tooth may be 1 mm across and bears up to 45 denticulations.
D, *Facelina auriculata* (Müller, 1776) var. *longicornis* (Montagu, 1808), adult body-length 30 mm, Lizard, Cornwall, radular formula 18x0.1.0. In this species, which is an active and voracious predator on gymnoblastic and calyptoblastic hydroids, each denticulate tooth measures up to 200 μ in width.
Plate III. Radulae of dorid nudibranchs.
A-C, Archidoris stellifera Vayssière, 1904, adult body-length 40 mm in spirit, Helford, Cornwall, radular formula 18x50.0.50 (including 5-7 rudimentary marginal teeth on each side of each transverse row). This species feeds upon encrusting siliceous sponges and the radula is adapted for scooping up shallow slices of the prey.
D, Cadlina laevis (L., 1767), adult body-length 14 mm in spirit, Cullercoats, Northumberland, radular formula 61x23.1.23. This micrograph shows the under-side of the radula and reveals details of the insertions of the bases of the teeth.
Plate IV. Radular teeth of Cadlina laevis (L., 1767).
A-C, teeth from near the centre of the radula.
D, teeth from the lateral extremity. Adult body-length 22 mm in spirit, Cullercoats, Northumberland, radular formula 67x24.1.24. This species is unusual among dorid nudibranchs in possessing a median tooth (not shown in the micrographs) and in having numerous denticulations on the lateral teeth, up to 20 per tooth, extending over ¼-½ of the cutting cusp of teeth situated near the centre of the radula, but over the whole length of the cusp in teeth near the lateral margins. The normal diet consists of encrusting littoral siliceous sponges.