THE METALLIC CONSTITUENTS OF MARINE GASTROPODS

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In 1933 McCance & Shipp (*a*) pointed out that one of the common marine molluscs, *Littorina littorea*, contained between 346 and 507 mg. of magnesium per 100 g. of live weight. While these enormous concentrations of magnesium were not confined to any one organ, the gonads and liver appeared to contain rather more than the foot and mantle. The object of the present paper is to report upon the mineral composition of some of the species allied to *L. littorea* and also of some of the other gastropods. The chemical methods used have been described in previous publications (McCance & Shipp 1933 *b*; McCance, Widdowson & Shackleton, 1936). The animals were all obtained from the Marine Biological Association at Plymouth, and the analytical results are set out in Table I, the approximate composition of sea water of 33 $^{0}/_{00}$ salinity being added for comparison (Harvey, 1928). When it was necessary to do so, the shells were broken to extract the animals, and in some instances fragments of shell were included in the material taken for analysis. The figures given for calcium, therefore, are in some instances too high, and in one or two cases the amount of calcium carbonate in the material taken has led to appreciable errors in the true water content, e.g. in *L. neritoides*.

The results which call for comment seem to be:

(1) The animals always contain less sodium than the surrounding water, but the amount of sodium per 100 g. of body water varies on both sides of, and is often not far from the amount of sodium per 100 g. of sea water.

(2) Judged by vertebrate standards, many of the animals contain surprisingly large amounts of potassium. Some of them, notably *L. rudis* and *Lacuna vincta*, contain more than 1000 mg./100 g., and it would be of considerable interest to know how this potassium was combined.

(3) The calcium in some of these animals may be quite small in amount but is always greater than that in the surrounding sea water, and may be extremely high even in animals in which shell contamination can be absolutely excluded. The most striking instances of this are the two Nudibranchia, *Jorunna* and *Archidoris*, the latter of which contains almost 2·5 % of calcium.

(4) The large amount of magnesium in the winkle (*Littorina littorea*) is confirmed. In *L. neritoides* and *L. rudis* the magnesium is also very high, but these magnesium contents are not peculiar to the Littorinas, for both *Nucella lapillus* and *Scaphander* contain similar amounts of magnesium, and in *Jorunna*, and particularly *Archidoris*, the magnesium concentrations are enormous

(McCance & Masters, 1937). It would seem that these marine molluscs may be divided into three groups according to their magnesium contents. The first, as illustrated by *Aeolidia*, *Mytilus edulis* and *Ostrea edulis* (see McCance & Shipp, 1933 *a*) contain much less magnesium than the surrounding water, and it is clear that in this respect their body water must differ radically in composition from the sea. In the second group, of which *Pecten maximus*, *Cardium*

TABLE I

Order and name	Organ	Water g.	Composition per 100 g. of live weight (mg.) Na	K	Ca	Mg	Fe	Cu
MESOGASTROPODA								
Littorina littorea	Foot and gut	69·5	688	425	821	456	25·8	1·77
	Gonad and liver	64·0	702	425	913	519	25·6	2·52
L. littoralis	Foot and gut	70·0	420	654	1480	150	9·4	4·73
	Gonad and liver	60·3	471	778	4350	256	15·2	9·13
L. neritoides	Whole animal	61·0	429	737	4500	332	26·5	10·2
L. rudis	Foot and gut	67·8	536	1000	1285	256	15·6	3·1
	Gonad and liver	62·7	695	728	3700	342	37·5	8·1
Lacuna vincta	Whole animal	69·5	724	1110	472	127	14·1	8·1
ARCHAEOGASTROPODA								
Patella vulgata	Whole animal	74·7	466	445	334	66·8	34·0	0·97
P. athletica	Whole animal (except radula)	79·2	432	213	348	84·1	15·3	0·67
Calliostoma zizyphinum	Foot and gut	74·2	678	383	278	90	19·8	5·4
	Gonad and liver	73·4	755	343	362	130	111·0	11·0
STENOGLOSSA								
Buccinum undatum	Foot and gut	73·2	431	413	75	114	2·5	0·55
	Gonad and liver	73·8	774	810	201	100	12·0	54·8
Nucella lapillus	Foot and gut	69·5	418	288	483	230	7·5	1·5
	Gonad and liver	64·1	548	217	378	208	12·0	5·3
TECTIBRANCHIA								
Scaphander lignarius	Whole animal	78·0	565	450	316	282	6·60	0·50
Aplysia punctata	Whole animal (excluding gastric plates)	86·0	635	240	115	114	10·4	0·70
NUDIBRANCHIA								
Aeolidia papillosa	Whole animal	79·0	—	—	62	60	12·5	—
Sphaerostoma hombergi	Whole animal	89·0	—	—	81	127	2·8	—
Jorunna tormentosa	Whole animal	85·0	450	240	580	620	15·7	2·16
Archidoris britannica	Whole animal	78·0	778	368	2460	1580	8·57	1·56
Sea water (from Harvey, 1928)		96·7	1033	37·9	41·3	128	—	—

edule (McCance & Shipp, 1933 *a*), *Buccinum undatum*, *Aplysia* and *Sphaerostoma* are examples, the concentration of magnesium in the animals is less than that in the surrounding water, but the concentration of magnesium in their body water appears to be close to that in sea water. The third group (*Archidoris*, *Jorunna*, *Littorina littorea*, etc.) contains huge concentrations of magnesium. Nothing is known of the state of combination of the metal except in the case of *Archidoris* (McCance & Masters, 1937), and even in this instance the function of the metal remains a matter of conjecture.

(5) The concentrations of iron vary from 2·5 to 111 mg./100 g. according

to the species and organ. The radulae of the Patellidae have formed the basis of a special study (Jones, McCance & Shackleton, 1935).

(6) Judged by mammalian standards, some of the copper concentrations are very high. The gonad and liver of *Buccinum* may be cited in illustration. At present one can only record the facts without reference to function.

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Summary

The sodium, potassium, calcium, iron and copper have been determined in sixteen marine gastropods, and the results are briefly discussed. A noteworthy finding is the large amount of potassium, calcium and (or) magnesium which may be present in these animals. *Lacuna vincta* for example may contain over 1·1 % of potassium, *Archidoris britannica* 1·58 % of magnesium per 100 g. of live weight.

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