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32. *Pelomys fallax*, Peters.

♀. 15. Kambove.

♂. 80; ♀. 73, 82. Bunkeya River.

"Native name 'Liwendi.' Resembles *Dasymys bentleyæ* in its habits."

33. *Georychus mellandi*, Thos.

♂. 40. Lualaba River.

♂. 42. Upper Lualaba River.

"Native name 'Mũko' or 'Malevi.'"

34. *Georychus amatus*, Wrought.

♂. 21, 22, 26; ♀. 24, 25. Katanga.

"Also called 'Mfuko.'"

XLVI.—*Notes on Locomotion and the Use of Slime-threads in the Marine Mollusca.* By NATHANIEL COLGAN, M.R.I.A.

WHILE engaged last year in studying the Nudibranch fauna of County Dublin the writer of these notes was induced to make some observations on the locomotive powers of certain species of marine Mollusca chiefly belonging to the Gastropoda, and as the results arrived at appear to be in some respects sufficiently novel to merit permanent record, they are set out here in some detail. In all 18 species were dealt with, 10 Prosobranchs, 7 Opisthobranchs, and 1 Filibranch, and the aim of the inquiry was not so much to determine the rate of travel of the various species as to ascertain whether any of them were accustomed to make use of suspensory slime-threads as an aid in locomotion.

Every student of the marine Mollusca is familiar with the fact that the Gastropods in general have a strong propensity to float foot upwards on any still-water surface they may be enabled to reach by crawling, and that many of them are accustomed to suspend themselves beneath that surface by means of slime-threads or attenuated strings of the mucus which all of them so freely secrete. But hitherto observation does not appear to have very conclusively established the fact that the power of re-ascending by such threads to the water surface is possessed by many of our native species of marine Mollusca. H. Wallis Kew, indeed, in his well-known paper on Spinning Molluscs in the 'Zoologist' for July 1900, states

that "most spinning Pectinibranchs no doubt are able to ascend to their former positions by crawling up the suspensory thread: this has been observed in *Litiopa*, in *Valvata*, and perhaps in *Rissoa*." The reference to *Rissoa* in this connexion is apparently drawn from Gray's account of the behaviour of *Rissoa parva* given in 1833 to the Zoological Society of London, where he states that the animal "has the power of emitting a glutinous thread by which it attaches itself to floating sea-weeds and is enabled when displaced to recover its previous position." Gray, too, in a later communication, published in these 'Annals' fifty years ago, (3) iv. 1859, p. 239, appears to attribute the power of re-ascension to the Opisthobranch *Elysia viridis*; but in this case, as in his note on *Rissoa parva*, his language is not quite clear.

Of the 18 County Dublin species placed under observation by me last year no less than 10 were seen to climb up along their suspensory slime-threads to the water surface from which they had descended; and I have little doubt that had material and opportunity been forthcoming for further observation, many others of the 18 would have shown themselves to possess the same power. As for the method of observation adopted, in all cases the living animals were placed in graduated tubes or phials of convenient size filled with fresh sea-water, which was renewed from time to time. For the smaller species tubes 2 inches high by $\frac{3}{4}$ inch in diameter were used, for the larger species phials 3 inches high by $1\frac{1}{2}$ inch in diameter, so that all of the individuals dealt with had ample water surface to float and travel upon. Several of the species were observed to drop, to all appearance voluntarily, from the water surface, and hang suspended beneath it by slime-threads; but in order to shorten the period of observation most of them were induced to assume this position by smartly tapping the bottom of the tube against the table on which it stood. As a rule there was little difficulty in so gauging the force of the tap and of the resultant jar as to dislodge the animal's foot from the slime-raft on which it had travelled out from the wall of the glass tube without altogether severing its connexion with that raft and causing the animal to sink to the bottom.

In all cases the animal was found to hang suspended from the posterior end of the foot, and the slime-thread by which it hung, fine and diaphanous though it was, could usually be detected by holding up the tube and examining the water with a hand-lens, while varying the strength of the light and the direction of its incidence on the tube. The graduation of the tubes and fluids was effected by narrow strips of white

paper gummed vertically along the outside of the glass and divided to eighths of an inch by heavy black lines clearly visible through the water, the white strip throwing out into relief the animal hanging suspended in front. The scale thus served to measure the rate of ascension of the animal, whether along its suspensory thread or in the more usual mode of locomotion along the glass wall of the tube.

With these few words on the method adopted, details will now be given as to the behaviour of the species observed to climb by their suspensory threads.

Runcina hancocki, Forbes.—Several specimens were collected at low water on the shore near Bullock Harbour on the 16th May last. One of the largest of these, nearly $\frac{1}{4}$ inch long when in motion, was transferred to a graduated glass tube, and while floating on the water surface was caused by a gentle tapping of the tube to sink to a depth of half an inch and hang there by its mucous thread. In two minutes it had regained the water surface, the front end of the foot being again and again brought into contact with the thread, so as apparently to grip it.

Limapontia nigra, Johnston.—One of several specimens collected at low tide near Bullock on the 2nd May last was observed on the 4th to mount a short way by a suspensory thread, but failed to reach the surface. Further particulars of this abortive attempt will be found farther on in the paragraph dealing with *Rissoa cingillus*.

Doto coronata, Gmelin.—A specimen of this rather common species dredged at Malahide on the 16th June last was observed on the same day to ascend by its thread from a depth of 1 inch in two minutes, the front of the foot during the operation being curled up and applied to the thread.

Eolis farrani, Ald. & Hanc.—Two specimens of this interesting species, which has its *locus classicus* at Malahide, Co. Dublin, where it was first discovered by Alder in 1844, were captured on *Zostera*-beds at Shennick's Island, Skerries, last year, one on the 1st and the other on the 18th July. The first specimen was seen to mount by its suspensory thread to the surface of the water from a depth of 1 inch in the space of one minute; the second specimen mounted by its thread in two minutes from a depth of 1 inch and a half. During the ascension the fore end of the foot was from time to time brought into contact with the thread, while the tentacles and papillæ kept up a vigorous motion.

Eolis drummondi, Thompson.—One of several fine specimens fully 1 inch long, dredged at Skerries, was transferred to a phial of sea-water on the 24th of July last. This was an extremely lively animal, its tentacles and numerous slender papillæ being in perpetual serpentine motion. Mounting rapidly to the water surface, it floated there foot upward until a gentle tap of the phial disengaged it and left it suspended from its slime-thread 2 inches below the surface. With what must have been a strenuous muscular effort the animal, while thus suspended by the tip of its slender tail, brought its head, or, rather, the fore front of its foot, again and again into contact with the slender suspensory thread, and vigorously working its tentacles and bristling papillæ in such a way as to render exact observation of its climbing method impracticable, it regained the water surface and resumed its floating position there in the space of one minute. Though the precise method of climbing was not perceptible, the ascent was clearly effected along and by means of the thread and by the application to it of the fore part of the animal's foot.

Skenea planorbis (Fabricius).—This diminutive species appears to be peculiarly addicted to the use of the suspensory thread both for descending from and ascending to the water surface, and though its absolute rate of progression is slow, yet in comparison with the size of the animal it is quite rapid. *Skenea* climbs by its thread fully four times its own length in one minute, while the much more swiftly moving *Eolis drummondi* accomplishes only twice its own length in the same time. Many specimens of *Skenea* collected at Bullock were placed under observation on the 19th April last, and several of these were seen to mount by their suspensory threads, the quickest rate of climbing being half an inch in two minutes, while the average of a number of such climbs by different individuals was found to be 1 inch in six minutes.

As with all the other species observed, the foot and tentacles of *Skenea* were in constant vigorous motion while the animal mounted by its thread to the water surface. Again and again one or other of the many floating individuals was seen to lower itself by its thread for $2\frac{1}{2}$ inches. On one occasion an individual having lowered itself by a series of jerky drops almost to the bottom of the tube, remounted one-eighth of an inch along its thread before it finally resumed its descent and reached the bottom; another, having descended in the same manner, remounted its thread for half an inch, or, say, for eight times its own length.

The slime-thread in this, as in all the species observed, was distinctly elastic. When one of the floating animals was gently pushed outwards by a needle-point from the side of the glass tube by which it had ascended, it would spring backwards towards the side as soon as the needle was withdrawn. The thread or film was evidently continuous along the side of the tube and over the water surface to the point where the animal floated. This was more than once made apparent in this way:—An individual floating quite close to the side of the tube would drop and suddenly come to rest about half an inch below the water surface and against the side of the tube. If the tube were then quickly moved from a vertical to an almost horizontal position the animal would be found hanging suspended across the tube from a point in the side. This suspension was evidently from a portion of the slime-thread formed by the animal in ascending, as the change of position of the tube was effected so quickly as to prevent the animal applying its foot afresh to the glass surface, and so producing a new attachment and a new thread.

The peculiar jerky method of descent by its slime-thread frequently observed to take place with this species appears to me to negative the idea that such motion is accidental or involuntary, as has been suggested by G. Sheriff Tye * and H. Wallis Kew † in their well-known papers on the subject of thread-spinning in the Mollusca. The abrupt pauses in and resumptions of the downward motion of *Skenea* appear to me to be explicable only on the assumption that the animal while descending, voluntarily and at intervals, inhibits and sets in action the discharge of mucus—in other words, that it makes its suspensory thread of set purpose. The appearances are inconsistent with an accidental lengthening of an elastic film, caused by the animal suddenly losing its foothold on the water surface, and so throwing its weight on that film at one point.

Rissoa striata (Adams).—This rather sluggish species, as it proved to be, was observed several times on the 1st May last to drop from the water surface and hang suspended by its thread. On one occasion the thread was seen to issue from the edge of the closed operculum, as if the animal had released itself from the water surface on which it crawled by withdrawing its foot. One individual was seen to mount its thread for three-quarters of an inch in two minutes, the

* Quarterly Journ. of Conchol. vol. i, p. 402 (Molluscan Threads).

† 'Zoologist,' no. 709, July 1900 (Spinning Molluscs).

motions of the foot during the process being similar to those observed in the species already mentioned.

Rissoa parva (Da Costa).—Several specimens of this very common littoral species were placed under observation on the 29th April last. It proved to be more active than its congener *R. striata*. Again and again, when by smartly tapping the tube a floating individual was caused to sink below the surface on its suspensory thread, it was seen to regain its floating position by climbing up the thread. On one occasion the anterior part of the foot was observed to be brought into contact with the thread as the animal ascended, and the water surface was seen to be drawn downwards into an inverted cone at the point of suspension. The quickest rate of thread-climbing observed in this species was half an inch in one minute.

Rissoa cingillus (Montagu).—A single specimen of this species along with six specimens of *Limapontia nigra*, all gathered in rock-pools at Bullock on the 2nd May last, were placed two days later in a glass tube of the usual dimensions, 2 inches by $\frac{3}{4}$ inch. In a short time all of the animals had crawled up the side of the tube and assumed the floating position foot upwards on the water surface. The tube was laid aside for a short time, and when the observation was resumed the *Rissoa* was found suspended by its thread at a depth of $\frac{1}{2}$ inch, and vigorously working its foot and tentacles as if engaged in climbing. Half of the *Limapontias* were missing, only three of the six placed in the tube being visible on the surface. On holding the tube against the light and bringing a hand-lens to bear on the suspended animal I found that the three missing *Limapontias* had attached themselves to the shell of the *Rissoa*, which was striving hard to lift itself and its living burden to the surface. Although one of the *Limapontias* was fully as large as the *Rissoa*, hardly three minutes had elapsed before the *Rissoa* had climbed up three-eighths of an inch. At this juncture one of the smaller *Limapontias* set out climbing the thread in advance on its own account. It had mounted only a short way, however, when it fell back on the *Rissoa*'s foot, and so hampered its action that the animal soon gave up its laborious efforts to reach the surface and sank slowly with its burden to the bottom of the tube.

Modiolaria discors (Linné).—This common species,

often found swarming in its juvenile state in the littoral zone of the Dublin coast, is the only Pelecypod whose habits of locomotion I have observed. A number of young individuals collected at Bullock on the 21st April last, and averaging $\frac{1}{8}$ inch in the longer diameter of the shell, were found to be expert climbers. Their method of climbing to the water surface, though in principle no doubt the same as that employed by the Gastropods, was utterly different in appearance. Instead of mounting the tube with an even gliding motion whose phases eluded observation, the young *Modiolaria*s hoisted themselves by intermittent and violent muscular contractions of an inordinately long foot, whose tip was anchored in advance of the animal, no doubt by a stiff mucus, as a preliminary to each upward lift of the animal and its shell. Watched with a hand-glass this operation conveyed a grotesque suggestion of a sailor climbing a rope hand-over-hand.

When halfway to the water surface one of the individuals, having withdrawn its foot completely into its shell, was seen, notwithstanding, to maintain its position on the side of the tube. A close scrutiny showed that the animal was fixed by a single delicate byssus thread neatly soldered to the glass by a terminal expansion. Before long I had the pleasure of watching the operation of byssus-making going on. The animal's foot was protruded to full length beyond the anterior end of the shell near to where the byssus-thread was fixed. For some seconds the foot was worked to and fro over the glass and then quickly withdrawn, when a second byssus-thread was seen to be fixed in position. After an interval of about a minute the foot was again shot out to full length, this time from the posterior end of the shell. Then for nearly half a minute the tip of the foot kept working over the side of the tube in a nervous, hasty, irresolute fashion, fumbling, in fact, and when it was at length withdrawn left three radiating byssus-threads fixed by their knobbed extremities to the glass.

In addition to the power of spinning a byssus, which it possesses in common with all the Mytilidæ, *Modiolaria discors* can produce a suspensory slime-thread and employ it in climbing. On the 24th April last one of many specimens left floating on the water surface in a tube was found to have lowered itself by a slime-thread to a depth of $\frac{3}{4}$ inch. When watched this individual was seen to climb slowly up its thread by applying to it the tip of its long foot, the whole ascent being made in four minutes.

The foregoing observations are, perhaps, sufficient to show that the practice of climbing by suspensory threads attached to the water surface, or, rather, to the mucous film supported by that surface, is quite usual amongst the littoral or shallow-water species of our marine Gastropods. Though the difficulties in the way of observing the motions of animals usually minute, and in all cases in violent action on an almost invisible thread, were too great to enable me to demonstrate the precise method of climbing adopted in any of the cases here recorded, there can be hardly any doubt that it was essentially the same as that described by Taylor in the following passage from his 'Monograph of the Land and Freshwater Mollusca of the British Isles.' Speaking of the well-known climbing habit of the land-slug, *Limax arborum*, he says (page 318):—"The same mucous filament can also be made use of if necessary to re-ascend to the point of suspension, this being accomplished by bringing the extremities of the body together and transferring the point of attachment of the suspensory filament from the tail to the head."

The rates of vertical travel up the sides of the graduated glass tubes of 16 out of the 18 species placed under observation were noted with some particularity, and a brief résumé of the results may be given here. Taking 1 inch as the standard distance, and giving to each species its quickest observed rate of travel, they may be arranged in order of slowness as follows:—First come *Rissoa striata*, *R. parva*, and *Modiolaria discors*, each crawling its inch in 3 minutes; *Trochus tumidus*, *Skenea planorbis*, and *Polycera lessonii* come next, each with 2 minutes to the inch; then *Cypræa europæa*, with $1\frac{1}{2}$ minute, *Littorina obtusata*, $1\frac{1}{3}$ minute, and *Rissoa cingillus*, $1\frac{1}{4}$ minute. Next we have *Trochus zizyphinus*, *Limapontia nigra*, and *Actæonia corrugata*, each with 1 minute to the inch, closely followed by *Nassa incrassata*, with 50 seconds. The elegant little *Trochus helycinus* takes only 35 seconds, and last and quickest of all come *Eolis farrani* and *E. drummondi*, each travelling at what may be accounted a dizzy rate for a marine Gastropod, accomplish an inch in 15 seconds and 13 seconds respectively.

All of these rates are rates of climbing rather than of simple travelling, since they were made on a vertical surface of smooth glass, and no doubt were considerably slower than the rates for the same species would have been on a horizontal surface. Taylor, in his Monograph already quoted from, has been pleased to calculate the mileage rate of several land and freshwater mollusks. Some of the more active land-slugs

he gives a rate of a mile in about 8 days, presumably on a horizontal surface, while *Ancylus fluviatilis*, he tells us, has been recorded to travel at the rate of a mile in 2 years and 10 months. It seems doubtful whether any of our marine Gastropods will be found to excel *Ancylus* in the deliberateness of its movements, while it is not improbable that *Eolis drummondi*, on the level, might be found to rival the speed of the Limaces, since the observations recorded in these notes show that the Nudibranch can climb at the rate of a mile in about 9 days 18 hours. To compare the small things of the organic world with the great things of the inorganic, the quickest travel rate of *E. drummondi* is some 260 times as great as the summer motion of the central and most rapidly moving portion of that famous ice-stream, the Mer de Glace.

XLVII.—*Alcyonarians from the Gulf of Cutch.* By Prof. J. ARTHUR THOMSON and Mr. GEORGE CRANE, B.Sc., University of Aberdeen. (Preliminary Note.)

IN the course of an investigation of the shallow-water fauna of part of the Gulf of Cutch, Mr. James Hornell made a small collection of Alcyonarians which presents some features of interest. The precise district was the coast of Okhamandal, which forms the N.W. extremity of the Kattiawar Peninsula, and Mr. Hornell has called our attention to the fact that specimens of *Dendronephthya* (better known as *Spongodes*), of *Lophogorgia*, &c. could be collected at low tide.

The collection includes eight species, one of which—*Astromuricea stellifera*—is new. There is also a new variety of a remarkable species of *Echinomuricea* previously found in the Indian Ocean.

The position of the various species may be indicated as follows :—

Order ALCYONACEA.

Family ALCYONIDÆ (1) *Sclerophytum polydactylum* (Ehrenberg).

Family NEPHTHYIDÆ .. (2) *Dendronephthya* (*Spongodes*) *dendrophyta* (Wright and Studer).
(3) *Dendronephthya* (*Spongodes*) *brevirama* (Burckhardt).