other words, the reef will advance nineteen times as slowly as it does 560 metres from the shore, whilst the surface which is exposed to the dissolving effect of the sea-water has also increased nineteen-fold. Where an ocean-current strikes such an incline, no Globigerina ooze can be deposited on it, and here the dissolving action of sea-water will balance the accumulation of coral debris long before such a height—of 1000 metres—is attained. It is clear that as soon as such equilibrium is reached there is a limit to the further extension of the reef in that direction. On the opposite side, however, where ooze will accumulate and protect the advancing reef from solution, such advance would be possible, but on that side the growth of coral is notoriously slow. Certainly, when the foot of the reef has advanced to depths below the zone of protecting Globigerina ooze no further lateral growth in any direction will be possible, and on the whole I should not think that lateral growth can play any considerable part in the formation of great reefs. Only positive coast-line shifting has such a result. In places where there is no such coast-line shifting (Gulf of Suez) the reefs are exceedingly small and insignificant.

Although therefore lateral growth no doubt does take place, it is not the actual cause of the formation of the great coral reefs.

We must, I think, revert to Darwin's subsidence theory, which is equally proved by the untenability of the hypothesis suggested for the purpose of superseding it, and by the direct evidence of the structure of the Triassic reefs in the Eastern Alps, which have actually attained their immense thickness during a period of positive shifting of the coast-line. R. VON LENDENFELD.

Innsbruck.

Slugs and Thorns.

IN NATURE, vol. xli. p. 393, I pointed out that thorns might not always be a protection from snails and slugs, since they were found in the stomach of a European slug, *Parma macella*. In further confirmation of this view, I have to-day dissected a number of sharp, straight, reddish-brown thorns, over a millimetre long, from the intestinal tract of *Ariolimax niger*, var. nov. *maculatus*, a slug of rather doubtful affinities (possibly referable to *A. andersoni*), received from Dr. J. G. Cooper, who found it under drift-wood at Haywards, California. It is curious that the thorns do not pierce the intestine, but they appear to cause no inconvenience. T. D. A. COCKERELL.

West Cliff, Colorado, April 21.

COMETS OF SHORT PERIOD.

IT is now generally accepted that the periodic comets of our system did not originate in it, but are bodies captured from outer space by one of the planets, the parabolic orbits in which they approached the system being transformed into elliptical ones. On account of the perturbing action of Jupiter, however, the orbits of short-period comets are liable to considerable modifications, and it is practically impossible to identify two apparitions of the same comet without laborious computations of the perturbations which it must have been subjected to between the two epochs. But even such computations may lead to a negative result, for frequently comets quite distinct have elements very much alike, probably because they are parts of an old comet travelling along the same orbit at greater or less intervals.

In some recent investigations on the capture theory of comets (*Bulletin Astronomique*, June and July 1889), M. Tisserand developed a relation that might be employed to determine the possibility of identity of comets whose elliptical elements are known. This criterion depends upon the fact that the velocity of a body revolving round a central one is the same for equal radius-vectors. In the case of a comet having a parabolic orbit coming under the influence of a planet, the latter plays the part of the central body, and the relative velocity of the comet with reference to it will be the same at the point of entry into the sphere of attraction as at the point of departure from it, the one point being in the old orbit, the other in the new one. If two comets are identical, their velocities

with reference to the perturbing planet will be the same at these points.¹

M. L. Schulhof has discussed the possibility of identity of several comets by means of M. Tisserand's formula (*Bull. Astr.*, November and December 1889, and *Astr. Nach.*, 2964), and the following tables contain the values of n found for those having periods from 3·3 to 8·8 years. In the first table, the comets whose periods are well known are given; in the second, those having uncertain periods. Comets which have undergone strong perturbations since discovery, and those for which perturbations prior to the first known apparition have been calculated, are given more than once, and the year indicated for which the elements are found. The symbols used have their usual signification, and l is the longitude of the comet at the point of nearest approach to Jupiter.

Comets of Known Period.

Name of Comet.	Elements of Orbit.						
	n	π	Ω	i	e	a	l
1. Denning, V. 1881 ...	0·414	19	66	7	0·83	4·23	223
2. Brorsen, 1842 ...	0·466	112	104	46	0·76	2·99	284
" 1890 ...	0·475	116	101	29	0·81	3·10	284
3. Finlay, VII. 1886 ...	0·483	8	52	3	0·72	3·54	205
4. Lexell, 1767 ...	0·483	26	352	33	0·33	4·45	163
" 1770 ...	0·486	356	132	2	0·79	3·16	184
" 1779 ...	0·478	159	178	18	0·91	60·10	184
5. Biela, 1772 ...	0·486	110	257	17	0·72	3·58	269
" 1852 ...	0·482	109	246	13	0·76	3·53	269
6. Wolf, 1868 ...	0·492	6	208	29	0·39	4·18	211
" III. 1884 ...	0·497	19	206	25	0·56	3·58	210
7. D'Arrest, 1851 ...	0·503	323	143	14	0·66	3·44	153
" 1883 ...	0·504	319	146	16	0·63	3·55	153
8. Faye, 1814 ...	0·509	55	225	7	0·56	3·83	212
" 1880 ...	0·507	51	210	11	0·55	3·85	208
9. Winnecke, 1809 ...	0·509	274	113	10	0·75	3·21	107
" 1886 ...	0·509	276	104	14	0·73	3·23	109
10. Tempel, 1869 ...	0·527	43	297	5	0·66	3·11	223
11. Brooks, 1885 ...	0·531	203	179	8	0·39	8·99	185
" V. 1889 ...	0·530	1	18	6	0·47	3·68	185
12. De Vico, 1678 ...	0·542	323	163	3	0·63	3·07	143
" I. 1844 ...	0·537	343	64	3	0·62	3·10	163
13. Barnard, II. 1884 ...	0·556	306	5	5	0·58	3·08	126
14. Tempel, 1873 ...	0·562	306	121	13	0·55	3·00	126
15. Tempel, 1856 ...	0·591	236	103	6	0·53	3·13	56
" 1885 ...	0·589	241	72	11	0·41	3·49	61
16. Encke, 1795 ...	0·591	157	335	14	0·85	2·21	335

Comets of Uncertain Period.

1. Comet of 1585 ...	0·484	10	38	5	0·70	3·61	213
2. Grischau, I. 1743 ...	0·525	93	87	2	0·72	3·09	271
3. Helfenzrieda, II. 1766 ...	0·493	251	74	8	0·86	2·93	80
4. Pigott, 1783 ...	0·473	50	56	45	0·55	3·26	233
5. Blainpain, IV. 1819 ...	0·517	68	78	9	0·71	3·11	248
6. Tuttle, III. 1858 ...	0·527	201	175	20	0·67	3·52	357
7. Coggia, VII. 1873 ...	0·484	86	249	26	0·76	3·19	255
8. Brooks, IV. 1886 ...	0·553	230	53	13	0·61	3·41	54
9. Swift, VI. 1889 ...	0·462	40	330	10	0·68	4·27	189

The value of n therefore found by the formula given is almost constant for the 21 known short-period comets, being contained within the limits 0·41 for Denning's comet, and 0·59 for Encke's and Tempel's comets.

It will also be seen that only five comets have their minimum distance to Jupiter's orbit between $l = 284^\circ$ and $l = 112^\circ$, while twelve have the point of nearest approach between $l = 153^\circ$ and $l = 233^\circ$. This unequal distribution along the ecliptic cannot be accidental, and

¹ M. Tisserand expressed the criterion very approximately by the formula—

$$\frac{1}{a_1} - \frac{1}{a_2} = \frac{2\sqrt{A}}{R^2} (\cos i_2 \sqrt{p_2} - \cos i_1 \sqrt{p_1}),$$

where $a_1, a_2, p_1, p_2, i_1, i_2$ are the semi-major axes, parameters, and inclinations of the old and new orbits; A and R the planet's semi-major axis and radius-vector at the point of nearest approach. This relation may be divided up into two parts, having the form—

$$n = \frac{1}{a} + \frac{2\sqrt{A}}{R} \cos i \sqrt{p}.$$