species, if such exist, in which the caste distinctions are still incipient. If it can be shown that the evolution of caste characters is in any way anterior to the loss of fertility, the difficulties of interpretation will disappear; at present the evidence points to the fact that owing to qualitative changes in nutrition, rather than simple malnutrition, an atrophy of the sexual organs is set up which is correlated with a hypertrophic modification of other structures, by a deflection, so to speak, of the nutritive stimulus.

Many neoteinic forms show no trace of wings. If the termite colony were headed by such forms only, the phenomenon, as Grassi points out, would occasion no surprise, but all valid evidence would be wanting that the species had ever possessed wings. This leads to the admission on his part that there is no proof that all existing wingless insects may not be descended from winged ancestors, and in the absence of such a proof he is led to reject Brauer's division of Insecta into Apterygogenea and Pterygogenea.

Space forbids any reference to the full account of the social life, habits and instincts of the species which Prof. Grassi has studied. Their intelligence, though remarkable, is far inferior to that of ants, and may be profitably contrasted therewith. Whilst referring to this subject, it may be worth while to call the attention of those interested in animal psychology to two lately-published pamphlets on the subject, particularly that on the psychology of ants,[1] by Father Wasmann, a most careful observer and thorough student of animal intelligence.

One practical result of Grassi's work requires mention. An isolated group of ten or a dozen Termites, containing any forms which have not begun to undergo the atrophic changes induced in the sterile castes, is capable of converting such forms into reproductive individuals; and the little society, thus started, possesses the power of multiplying into a large colony.

It is therefore hopeless to attempt the extermination of Termites merely by the destruction of the kings and queens.

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PERIODICAL COMETS.

THE number of comets of short period which are expected to return to perihelion during the next two years is remarkable. In 1898 the following comets are due :—Pons-Winnecke (April), Encke (May), Swift, 1889 VI. (June), Wolf (June), Tempel, 1867 II. (September); in 1899, Denning, 1881 V. (January), Tempel, 1866 I. (March), Barnard, 1892 V. (April), Tuttle, 1858, I. (May), Holmes (May), and Tempel 1873 II. (July). In addition to these, 1898 may possibly witness a return of Biela's comet, last seen in 1852, and of Coggia's, 1873 VI.; but these are doubtful, and the prospect of re-observing them appears to be very limited. Thus there are thirteen known comets which may present themselves for detection, but several of them will be enabled to elude observation in consequence of their unfavourable position, and in one or two cases the objects may escape owing to the uncertainty now existing as to the exact periodic times.

Apart from the large number of interesting comets which are likely to be visible, several fine meteoric showers will probably occur, for the Leonids are due in considerable abundance on November 14, 1898, 1899 and 1900, while the Andromedes ought to reappear on November 23, 1898. Both for the cometary and meteoric observer we are, therefore, entering upon a period very prolific in important phenomena.

During the first quarter of the present century the number of cometary discoveries averaged about one per annum. The present average is about five, including periodical comets, which represent no small proportion of the whole. The rapid increase, during the last twenty years, in the number of comets of short period is very striking, and proves not only that these bodies are exceedingly plentiful, but also that the field of discovery is not nearly exhausted. They belong to the Jovian family, with periods ranging from five to nine years. Encke's comet furnishes rather an exceptional case, the period being only 3·3 years, and considerably shorter than that of any other known.

Perhaps it may be interesting to make a brief seriatim reference to the expected comets of the next two years :—

Pons-Winnecke.—This comet, due in April 1898, was well observed at its last return to perihelion in June 1892. The ensuing return will not be so favourable, as the comet will be much more distant from the earth, and visible only in the morning sky. This return will be much the same as in 1875, four periods of the comet being equal to twenty-three years; thus perihelion occurred on June 30, both in 1869 and 1892.

Encke.—Returns in May 1898. The comet will not be so well placed, owing to its southern position, as at its last return, when it was quite conspicuous in December 1894 and January 1895. Observations may be made satisfactorily from the southern hemisphere after the perihelion passage, as in 1832 and 1865, when the comet was discovered in June. At intervals of thirty-three years (=10 revolutions of the comet) it comes to perihelion at nearly same times as before, and its apparent path in the heavens is repeated.

Swift, 1889 VI.—Considerable uncertainty is attached to the orbit of this comet. Hind deduced a period of 8·534 years, which would bring the comet back at midsummer 1898; but Coniel has more recently determined the period as 8·92 years, with an uncertainty of 0·9 year. If this object is redetected, it will probably be picked up accidentally by some one engaged in comet-seeking. The most favourable returns are those when it reaches perihelion in October or November.

Wolf.—This comet, which will reach its perihelion in June 1898, was favourably observed in 1884 and 1891; but in 1898 the conditions are not nearly so good. The following ephemeris for the next return is by A. Berberick (*Ast. Journal*, 253).

Date.	R.A. h. m.	Dec.	Light.
1898.—June 3	1 42·3	+18° 18′	1·7
July 5	3 18·3	+19 43	2·1
Aug. 6	4 49·3	+16 51	2·3
Sept. 7	6 4·9	+10 2	2·4
Oct. 9	6 56·9	+ 0 38	2·4
Nov. 10	7 17 9	− 9 21	2·4
Dec. 12	7 4·1	−16 20	2·1
1899.—Jan. 13	6 34·1	−16 31	1·4

(Brightness May 1, 1891 = 1.)

Dr. Berberick remarks that later returns of the comet will be unfavourable. Seven of its revolutions are equal to three of Jupiter, and a second approach of these bodies will occur in 1922–23, depriving us perhaps of the sight of the comet for a long time, if not for ever.

Tempel, 1867 II.—Comes to perihelion in September 1898. This comet was re-observed in 1873 and 1879, but has not been seen since, though it has twice returned to perihelion in the meantime. The conditions in 1898 are not very good. The periodic time was about six years in 1867, 1873 and 1879; but perturbations by Jupiter have considerably lengthened the period according to Gautier. It is most important that the comet should be redetected if possible.

Denning, 1881 V.—Returns to perihelion in January 1899, but under circumstances not nearly so favourable as in 1881. In January and February its distance from the earth will be about 100 millions of miles, and about

[1] "Instinct und Intelligenz im Thierreich," and "Vergleichende Studien über das Seelenleben der Ameisen und der höhern Thiere," by Erich Wasmann, S.J. (Freiburg, 1897).

the same as when last seen in the Strassburg refractor of 20 inches aperture, on November 24, 1881. In view of the doubts prevailing as to its exact period, it is questionable whether it will be redetected in 1899. At its following return in 1907 the comet ought to be conspicuously visible for some months, as it will be comparatively near to the earth, and the favourable return of 1881 will be repeated, three periodic revolutions (1 = 8·687 years) of the comet being equal to twenty-six years. At its last return in 1890 May, the position of the comet was such that it never approached within 150 millions of miles of the earth, and thus it entirely escaped observation.

Tempel, 1866 I.—This comet is due in the spring, but it will be separated from the earth by a much wider interval than in 1866. Its favourable returns are those when perihelion occurs in about November or December. If the comet has the same periodic time as its associated meteor shower (the Leonids), then it is well visible at one return only out of every three, and its next favourable apparition will occur in 1965–6.

Barnard, 1892 II.—The period of this faint comet (discovered by photography) is somewhat doubtful. Hind gave 6·64 years, Krueger 6·309, Porter 6·18, and Coniel 6·52. The comet will probably return to perihelion in the spring of 1899, when it will, however, be invisible, being obliterated in the sun's rays. When the comet reaches its perihelion in the autumn it can be well observed.

Holmes.—This comet returns to perihelion in April 1899 according to Zwiers, the probable error being 0·72 day. His orbit was derived from 600 observations. Dr. Kohlschütter has also given a definitive orbit for this comet, his periodic time for it being 2520·829 days, while Zwiers gives 2521·2 days. The latter, after allowing for perturbations by Jupiter and Saturn, gives April 27·97 as the date of perihelion, and his ephemeris for 1898, as abridged, is as follows:—

Greenwich Noon, 1898.

	R.A.	Dec.
	h. m.	° ′
Feb. 16 ...	16 26 ...	−42 7
Mar. 18 ...	16 52 ...	−45 44
April 17 ...	17 0 ...	−49 20
May 17 ...	16 41 ...	−51 49
June 16 ...	16 5 ...	−51 1
July 16 ...	15 46 ...	−47 10
Aug. 15 ...	15 56 ...	−43 2
Sept. 14 ...	16 31 ...	−39 55

The comet must therefore be looked for at southern observatories, in 1898; it will be well placed for northern observers in 1899.

Tuttle.—This comet, first discovered by Mechain in 1790, and re-observed by Tuttle in 1858, was also seen in 1871 and 1885. It belongs to Saturn's comet family, its orbit, at aphelion, being just outside that of Saturn. The conditions are not favourable for seeing the comet at the ensuing return in the summer of 1899, as its longitude of perihelion is 116°, and perihelion distance 1·03, or about 3 millions of miles outside the earth's orbit. The comet is therefore best visible when it comes to perihelion at the end of January, the earth and comet being then on the same side of the sun, and only a few millions of miles distant from each other.

Tempel, 1873 I.—Returns early in July 1899, and will be observed under pretty good conditions, the earth and comet being on the same side of the sun. The comet will be visible during the whole night, and is likely to be as successfully observed as in 1873, when it was first discovered, for five of its periods of 5·20 years are equal to twenty-six years.

No doubt some of our largest telescopes will be employed in the redetection of these objects as they severally return to perihelion. In recent years the diligence of observers has been the means of increasing the number of periodical comets at the average rate of one per year, and this increase will probably be maintained, if not exceeded, in the future.

It might be supposed that comets returning to the sun at comparatively short intervals would soon be all detected; but when the circumstances are considered, it will be seen that this state of things will be never realised. The comets of short period are faint objects, and often pass their perihelia under conditions which render them totally invisible. Thus De Vico's of 1844 was computed by Brünnow to have a period of 5·469 years, but it was not seen again until 1894, though during the fifty years it had returned unobserved on eight occasions. Pons's comet of 1819 was assigned a period of 5·618 years by Encke, but it was not seen at any of the six subsequent returns. Winnecke, however, in 1858, at its seventh return, picked it up accidentally. Mechain's comet of 1790, with a period of 13·8 years, must have returned in 1803, 1817, 1830 and 1844, but it eluded re-observation until Tuttle recovered it in January 1858.

Most of the periodical comets at perihelion are outside the earth's orbit, and hence it follows that they escape observation unless the earth is on the same side of the sun as the comet. As an instance of the favourable presentation of a comet, that of 1894 I. may be alluded to. Its perihelion is 14 millions of miles outside the earth's orbit, and is in longitude 130½°, which it reached on February 9. Now the earth was in longitude 140° at the same time, so the comet was nearly in opposition and visible under the most favourable circumstances during the whole night.

Some comets, as Tempel-Swift's, are only perceptible at alternate returns; others are not well visible except at intervals after two, three, or four returns.

Another circumstance which will prevent our exhausting the discovery of these objects, is that the planet Jupiter frequently introduces disturbances into their motions, and possibly into the physical conformations of the short period comets. He appears, also, capable of effecting new captures, and thus bringing these bodies into permanent membership of the solar system. The Jovian family of comets is already a numerous one, and is probably increasing, though some of the objects which owe allegiance to Jupiter are in process of disruption and gradual dispersion, and seem likely in the end to lose their visible character, as compact bodies, to form meteoric streams with the residue of their material. Biela's comet has not been seen for forty-five years, though it ought to have returned six times in that interval, and was one of the earliest discovered, as well as one of the best known, of the periodical comets. It will probably never be seen again as a comet, though its associated meteors will be displayed in November 1898, and in future years at periods conforming with the time of revolution of the parent comet.

We must, however, not be too hasty in assuming the collapse of known comets, for experience has taught us that they may reappear when least expected. The visible return of De Vico's comet of 1844, after being unseen for fifty years, and of Pons's comet of 1819, after an invisibility of thirty-nine years, shows us what is possible. Brorsen's comet, which escaped observation in 1884, 1890 and 1895, is supposed to have disappeared like Biela's, but a small comet may be swept up at some future time which will exhibit a similarity of elements to that of the missing Brorsen sufficient to prove the actual identity of the two objects.

The distribution of the aphelia of periodical comets near the orbits of the major planets is not the least interesting feature connected with these bodies. But it is perhaps a little remarkable that though Jupiter's family has enormously increased in recent years, yet the other groups have received very few, if any, additions, though a large number of new comets have been discovered.

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