contribution to our columns Dr. Moreno stated his belief that the animal belonged to the genus *Glossotherium* (= *Grypotherium*), the creation of a new genus (*Neomylodon*) for its reception being accordingly superfluous. Accepting this determination, but using the synonym *Grypotherium*, Dr. R. Hauthal, in a paper recently communicated to the "Revista del Museo de la Plata" (vol. ix. p. 409), comes to the conclusion that the animal in question was kept by the prehistoric Indians of Patagonia in a domesticated state, and that the cave at Ultima Esperanza was the stable where the herd was nightly collected! Several specimens of the hide, as well as abundant droppings in a dried state, have been obtained; but in spite of this, the author is of opinion that all the remains date from prehistoric times. And he gives reasons for the belief that the creature cannot be living at the present day. Considering the animal in question to be distinct from the typical species, the author and his colleague Mr. Roth bestow the new title *G. domesticum*, apparently oblivious of Dr. Ameghino's earlier name *listai*. The promised continuation of this remarkable paper will be awaited with interest.

SOME very interesting features in development are brought to light in Mr. J. S. Budgett's "Notes on Batrachians of the Paraguayan Chaco," published in the last issue of the *Quarterly Journal of Microscopical Science*. It is well known that in some of the arboreal frogs the tadpole stage, to meet the necessities of existence, is more or less abbreviated; and the author describes an instance of this in a species of *Phyllomedusa*, illustrating his notes with a beautiful coloured plate. After mentioning how the male and female hold together the edges of a leaf (which afterwards become united by the jelly of the egg-mass) during oviposition so as to form a funnel for the reception of the eggs, the developmental stages are described in detail. In the short period of six days the embryo leaves the egg as a pellucid tadpole of a bright green colour, whose only conspicuous parts are its eyes. The tadpole, which may have to travel several inches in order to reach the water, is hatched without a trace of yolk, and with the loss of external gills; breathing taking place by means of a median spiracle, and the lungs being distinctly visible through the body-wall. Pigment is locally developed next day; and at the end of about five weeks the hind limbs appear. When both pairs of limbs are developed, the young frog lands, and sits quietly among the grass till its tail is completely absorbed, when it is practically adult.

THE second volume of Prof. G. O. Sars' work on the Crustacea of Norway, dealing with the Isopoda, has just been completed. The volume is the first in which the Scandinavian Isopoda are treated as a whole, and it should be of much practical use to zoologists. The third volume of the work, now in preparation, will treat of the anomalous group Cumacea, and will consist of about 150 pages with sixty plates.

AT the Royal Victoria Hall, Waterloo Bridge Road, the following popular science lectures will be delivered on Tuesday evenings during October:—October 3, "The Value of Nitrogen," Prof. Holland Crompton, F.R.S. October 10, "Liquid Air," Prof. W. Ramsay, F.R.S. October 17, "Source and Course of the River Thames," Dr. C. G. Cullis. October 24, "Photographs taken in the Dark," Dr. Russell, F.R.S. October 31, "Kamchatka," Captain Barrett Hamilton.

THE additions to the Zoological Society's Gardens during the past week include a Maholi Galago (*Galago maholi*) from South Africa, presented by Mr. James W. Park; two Black-eared Marmosets (*Hapale penicillata*) from South-east Brazil, presented by Mr. F. M. Still; a Guinea Baboon (*Cynocephalus sphinx*, ♀) from West Africa, presented by Mr. J. Huxley; a Black-backed Jackal (*Canis mesomelas*), four Bristly Ground Squirrels (*Xerus setosus*), a Vulturine Eagle (*Aquila verreauxi*, juv.), two Hispid Lizards (*Agama hispida*), four Delalande's Lizards (*Nucras delalandii*), seven Rufescent Snakes (*Leptodira hotambaeia*), four Crossed Snakes (*Psammophis crucifer*), five Rhomb-marked Snakes (*Trimerorhinus rhombeatus*), eight Rough-keeled Snakes (*Dasypeltis scabra*), an Infernal Snake (*Boodon infernalis*), two Puff Adders (*Bitis arietans*) from South Africa, presented by Mr. J. E. Matcham; a Fulmar (*Fulmarus glacialis*) from Iceland, presented by Mr. G. S. Hett; a Lapwing (*Vanellus cristatus*), British, presented by the Rev. A. Barham Hutton; a Herring Gull (*Larus argentatus*), British, presented by Mr. J. L. Bell; two Common Chameleons *Chamaeleon vulgaris*) from North Africa, presented by Mr. Ronald H. Archer; a Common Viper (*Vipera berus*), British, presented by Mr. P. Debell Tuckett; a Kinkajou (*Cercoleptes caudivolvulus*) from South America, an Arctic Fox (*Canis lagopus*) from Finland, a Palm Squirrel (*Sciurus palmarum*, albino) from India, a Black-headed Conure (*Conurus nanday*) from Paraguay, deposited.

## *OUR ASTRONOMICAL COLUMN.*

HOLMES' COMET 1899 *d* (1892 III.).—

*Ephemeris for 12h. Greenwich Mean Time.*

| 1899. | R.A. h. m. s. | Decl. ° ′ ″ | Br. $r^{-2}$ | Br. $(r\Delta)^{-2}$ |
|---|---|---|---|---|
| Sept. 21 | 3 9 35 98 | +44 45 19·7 | 0·1758 | 0·05727 |
| 22 | 9 31·29 | 44 57 20·3 | | |
| 23 | 9 24·28 | 45 9 10·2 | | |
| 24 | 9 14·91 | 45 20 49·1 | | |
| 25 | 9 3·18 | 45 32 16·4 | 0·1740 | 0·05809 |
| 26 | 8 49·09 | 45 43 31·8 | | |
| 27 | 8 32·62 | 45 54 34·8 | | |
| 28 | 8 13·75 | 46 5 25·0 | | |
| 29 | 7 52·50 | 46 16 2·0 | 0·1721 | 0·05881 |
| 30 | 7 28·86 | 46 26 25·1 | | |
| Oct. 1 | 7 2·85 | 46 36 34·1 | | |
| 2 | 6 34·46 | 46 46 28 2 | | |
| 3 | 3 6 3·71 | +46 56 7·2 | 0·1702 | 0·05939 |

NEW SPECTROSCOPIC MULTIPLE STAR.—The San Francisco correspondent of the *Standard* (September 11) reports that Prof. W. W. Campbell, of the Lick Observatory, announces that he has obtained spectroscopic evidence that the North Pole star, Polaris, is in reality a system consisting of three bodies. Two of these revolve round each other in a period of *four* days, and simultaneously they together revolve around a third body, in the same manner as the earth and planets revolve round the sun. It is improbable that any of these distant bodies will ever be visible separately, their distance from each other being so small that it can only be detected by the change in wave-length of the lines in the spectrum of the system, owing to the continual approach and recession of each component during their mutual revolutions.

SOUTHERN VARIABLE STARS.—In the *Astronomical Journal* (No. 468), Mr. R. T. A. Innes gives the results of observations on variable stars made at the Cape Observatory since 1896. The working catalogue was mainly derived from lists supplied by Prof. J. C. Kapteyn, who noted all suspected cases of variability in the course of his work on the *Cape Photographic Durchmusterung*. The present communication considers twenty-seven stars, of which one is probably of the Algol type. The period of this is found to be 12·906 days, and consequently this star is conspicuous as being the longest period Algol variable. Its position is

$$\left.\begin{array}{l}\text{R.A. 7h. 42m. 41·1s.}\\ \text{Decl. } -41^\circ\ 4'\!\cdot\!0\end{array}\right\}(1875)$$

The visual variation of magnitude is from 9·5 to 10·7, and photographically from 9·3 to 10·2.

THE *Bulletin de la Société Astr. de France* for September contains several interesting papers.—"Photography of stellar spectra," by Prof. A. Cornu, consists of a short description of the methods and results of researches into stellar constitution. MM. Flammarion and Antoniadi describe their most recent observations of Mars, including illustrations showing the landmarkings and the variations of the polar cap with the seasons.—M. Em. Touchet contributes an illustrated account of his successful attempt to photograph the "shadow cast by the planet Venus." This he did on January 11, with an exposure of fifteen minutes, the object casting the shadow being an incandescent bulb-holder placed about 21 cm. from the plate.—Lastly, rather more than nine pages are devoted to a dissertation, by M. Rideau, on "the satellites of Jupiter," dealing with their dimensions, surface, probable variability of brightness, eclipse and other phenomena.

## *SOLID HYDROGEN.*[1]

IN the autumn of 1898, after the production of liquid hydrogen was possible on a scale of one or two hundred c.c., its solidification was attempted under reduced pressure. At this time, to make the isolation of the hydrogen as effective as possible, the hydrogen was placed in a small vacuum test-tube, placed in a larger vessel of the same kind. Excess of the hydrogen partly filled the circular space between the two vacuum vessels. The apparatus is shown in Fig 1. In this way the evaporation was mainly thrown on the liquid hydrogen in the annular space between the tubes. In this arrangement the outside surface of the smaller tube was kept at the same temperature as the inside, so that the liquid hydrogen for the time was effectually guarded from influx of heat. With such a combination the liquid hydrogen was evaporated under some 10 mm. pressure, yet no solidification took place. Seeing experiments of this kind required a large supply of the liquid, other problems were attacked, and any attempts in the direction

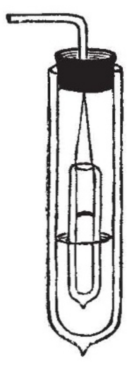

FIG 1.

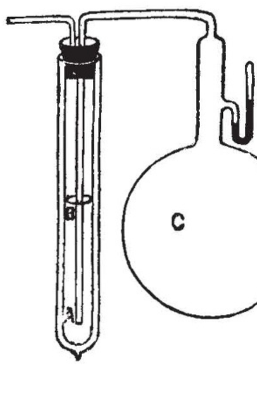


FIG 2.

of producing the solid for the time abandoned. During the course of the present year many varieties of electric resistance thermometers have been under observation, and with some of these the reduction of temperature brought about by exhaustion was investigated. Thermometers constructed of platinum and platinum-rhodium (alloy) were only lowered 1½° C. by exhaustion of the liquid hydrogen, and they all gave a boiling point of −245° C., whereas the reduction in temperature by evaporation *in vacuo* ought to be 5° C., and the true boiling point from −252° to −253° C. In the course of these experiments it was noted that almost invariably there was a slight leak of air, which became apparent by its being frozen into an air snow in the interior of the vessel, where it met the cold vapour of hydrogen coming off. When conducting wires covered with silk have to pass through india-rubber corks it is very difficult at these excessively low temperatures to prevent leaks, when corks get as hard as a stone, and cements crack in all directions. The effect of this slight air leak on the liquid hydrogen when the pressure got reduced below 60 mm. was very remarkable, as it suddenly solidified into a white froth-like mass like frozen foam. My first impressions were that this body was a sponge of solid air containing the liquid hydrogen, just like ordinary air, which is a magma of solid nitrogen containing liquid oxygen. The fact, however, that this white solid froth evaporated completely at the low pressure without leaving any substantial amount of solid air led to the conclusion that the body after all must be solid hydrogen. This surmise was confirmed by observing that if the pressure, and therefore the temperature, of the hydrogen was allowed to rise, the solid melted when the pressure reached about 55 mm. The failure of the early experiment must then have been due to supercooling of the liquid, which is prevented in this case by contact with metallic wires and traces of solid air. To settle the matter definitely, the following experiment was arranged. A flask, C, of about a litre capacity, to which a long glass tube bent twice at right angles was sealed, as shown in Fig. 2, and to which a small mercury manometer can be sealed, was filled with pure dry hydrogen and sealed off. The lower portion, A B, of this tube was calibrated. It was surrounded with liquid hydrogen placed in a vacuum vessel arranged for exhaustion. As soon as the pressure got well reduced below that of the atmosphere, perfectly clear liquid hydrogen began to collect in the tube A B, and could be observed accumulating until, about 30 to 40 mm. pressure, the liquid hydrogen surrounding the outside of the tube suddenly passed into a solid white foam-like mass, almost filling the whole space. As it was not possible to see the condition of the hydrogen in the interior of the tube A B when it was covered with a large quantity of this solid, the whole apparatus was turned upside down in order to see whether any liquid would run down A B into the flask C. Liquid did not flow down the tube, so the liquid hydrogen with which the tube was partly filled must have solidified. By placing a strong light on the side of the vacuum test-tube opposite the eye, and maintaining the exhaustion to about 25 mm., gradually the solid became less opaque, and the material in A B was seen to be a transparent ice in the lower part, but the surface looked frothy. This fact prevented the solid density from being determined, but the maximum fluid density has been approximately ascertained. This was found to be 0·086, the liquid at its boiling point having the density 0·07. The solid hydrogen melts when the pressure of the saturated vapour reaches about 55 mm. In order to determine the temperature, two constant volume hydrogen thermometers were used. One at 0° C. contained hydrogen under a pressure of 269·8 mm., and the other under a pressure of 127 mm. The mean temperature of the solid was found to be 16° absolute under a pressure of 35 mm. All the attempts made to get an accurate electric resistance thermometer for such low temperature observations have been so far unsatisfactory. Now that pure helium is definitely proved to be more volatile than hydrogen, this body, after passing through a spiral glass tube immersed in liquid hydrogen to separate all other gases, must be compared with the hydrogen thermometer. For the present the boiling point which is 21° absolute at 760 mm., compared with the boiling point at 35 mm., or 16° absolute, enables the following approximate formula for the vapour tension of liquid hydrogen below one atmosphere pressure to be derived:—

$$\log p - 6{\cdot}7341 - 83{\cdot}28/T \text{ mm.},$$

where T = absolute temperature, and the pressure is in mm. This formula gives us for 55 mm. a temperature of 16·7° absolute. The melting point of hydrogen must therefore be about 16° or 17° absolute. It has to be noted that the pressure in the constant volume hydrogen thermometer, used to determine the temperature of solid hydrogen boiling under 35 mm., had been so far reduced that the measurements were made under from one-half to one-fourth the saturation pressure for the temperature. When the same thermometers were used to determine the boiling point of hydrogen at atmospheric pressure, the internal gas pressure was only reduced to one-thirteenth the saturation pressure for the temperatures. The absolute accuracy of the boiling points under diminished pressure must be examined in some future paper. The practical limit of temperature we can command by the evaporation of solid hydrogen is from 14° to 15° absolute. In passing it may be noted that the critical temperature of hydrogen being 30° to 32° absolute, the melting point is about half the critical temperature. The melting point of nitrogen is also about half its critical temperature. The foam-like appearance of the solid when produced in an ordinary vacuum is due to the small density of the liquid, and the fact that rapid ebullition is substantially taking place in the whole mass of liquid. The last doubt as to the possibility of solid hydrogen having a metallic character has been removed, and for the future hydrogen must be classed among the non-metallic elements.

[1] Read before the British Association (Section B), Dover Meeting, by Prof. James Dewar, F.R.S.