consideration all volcanic action involving the extensive eruption of lavas, whether dry or saturated with water. They also exclude the maar process (single explosion) as an explanation of medium and large craters, but not as an explanation of small craters. The volcanic theory, as a whole, is therefore rejected, but a limited use may be found for the maar phase of volcanic action in case no other theory proves broad enough for all the phenomena.

(To be continued.)

GAS ANALYSIS BY SOUND.

A NOVEL method of analyzing mixtures of two gases of different densities has been brought under the notice of the French Academy of Sciences by M. Hardy. It depends upon the application of sound vibrations; and the apparatus is called by its inventor a formenophone, because it is primarily designed for the purpose of determining the proportion of formene, or fire damp, in the air of coal mines. This appliance consists of two organ pipes, of exactly the same dimensions, and giving out the same note when blown with air under ordinary conditions. If one of these pipes is filled with normal air, and the other with air containing say 1 per cent. of marsh gas, and the pipes are then sounded, the unison is disturbed, and one beat is heard every three seconds. With 2 per cent. of marsh gas in the air, there are three beats in two seconds; with 3 per cent., two beats per second; and so on. Similar results may be obtained when carbonic acid gas is the added impurity. M. Hardy gave figures of determinations with organ pipes sounding C. For mixtures having a density closely approaching that of air, pipes sounding C₄ are more suitable. Each determination is the work of a few seconds; and the inventor believes the apparatus to be of great practical value for the analysis of suspected air taken from mines or other inclosed spaces. It is interesting to note, in connection with this communication, that the phenomenon upon which M. Hardy's method is based is a well-known concomitant of organ performances in concert halls or churches where the air is liable to marked carbonic acid pollution through lack of proper ventilation. At the close of a crowded assemblage in such places the organ pipes give quite a different pitch of sound from that with which they began.

PROPERTIES OF DIAMONDS.

MOISSAN has given the results of an investigation to determine the temperature at which diamonds begin to burn in oxygen, these temperatures being measured by means of a thermoelectric couple. As the temperature is slowly raised, the combustion takes place slowly and without the production of light, the only evidence of it being the effect produced by the issuing gas on solution of baryta. At about 40° to 50° above this slow combustion temperature, the burning becomes rapid and a distinct flame is visible. The eight different specimens examined gave results as follows: Yellowish-brown carbonado burned at 690° with flame; black carbonado at 710°—720° with flame; transparent Brazilian diamond at 760°—770° without a flame; cut diamond from the Cape at 780°—790° without a flame; Brazilian bort at 790° without a flame and at 840° with a flame; Cape bort at 790° without a flame and at 840° with a flame; very hard bort at 800° without and at 875° with a flame. The harder the diamond, as a rule, the higher its point of ignition. Heated in hydrogen to 1,200° Cape diamonds do not lose weight, though they may lose their transparency and become lighter in color. At this temperature dry chlorine and dry hydrogen fluoride have no action on them. The vapor of sulphur attacks them only at 1,000°; but with carbonado, carbon disulphide is produced at 900°. The vapor of sodium has no action at 600°. Iron at its fusing point attacks the diamond readily and graphite separates on cooling. When heated with alkali carbonates at a high temperature the diamond is rapidly dissolved with evolution of carbon monoxide but no hydrogen. Hence it cannot contain hydrocarbons.—C. R., *Amer. Jour.*

UNIVERSAL POLYMERISM OR POLYSTERISM.

By HENRY WURTZ, Ph.D.

ALL intelligent metal-workers know that metals vary in their qualities according to the special treatment and handling they receive. The same principle, as can be proved, applies to all bodies whatever, both solid and liquid.

Chemists have in very recent years begun to give some attention to these internal transformations through external causes. Sterry Hunt, Walther Spring, of Liege, and the eminent metallurgist Roberts-Austen may be mentioned as examples, among others. The present writer wrote of it as long ago as 1875, in a memoir entitled *Geometrical Chemistry*, which will be found, in abstract, in the *Am. Chemist*, March, 1876. Being during that year in continual association with Sterry Hunt, at the Philadelphia Exposition—both being members of the international groups of judges, we discussed these things extensively, and Hunt has approximated in some of his later writings to the views of the present writer as to the universality of "polymerism." In books published by him just before his lamented death, such as his "New Basis for Chemistry," and others, he has made it the main foundation of his theories. Before 1876 he seemed to the writer to share the usual view of chemists and mineralogists, that each distinct chemical element and compound should possess a distinct, definite and characteristic specific gravity, and that the variations of the figures obtained by different experimenters were due to impurities, errors of manipulation, differences of temperature, and other incidents more or less vaguely assumed. As to errors, this notion is wholly inadmissible. For chemists, the names given below will suffice to disprove this. With due skill and care—without which these men never worked—there is no difficulty in obtaining, with the same material, density figures agreeing even to the third place of decimals, or certainly to half the second place, and more especially with heavy metals. And chemists of this class never, or very rarely, work on any but chemically pure bodies.

The main object of the writer in preparing this ta-

ble, has been to demonstrate conclusively to workers in metals the fact of the liability of the materials they work with to these variations in density, and thus lead to introduction into their minds of novel ideas on this subject. It may lead some practical men to study for themselves the modes of producing such variations at will, accompanied, as they must be, by corresponding variations in all the other qualities of the metal. It should be repeated that this is a branch of chemistry which the writer believes to be as universal, as fundamental, and as important as any other whatever, and which has been hitherto unappreciated, and therefore ignored and neglected, almost universally by chemists.

It would have been interesting to add to this table, were it not probably too long already, some of the commoner chemical compounds, such as occur, for example, as pure crystallized substances obtained from solutions and otherwise, and which also show variations, sometimes even to a greater extent than the metals. This was probably for the first time pointed out in 1852 by the German chemist Kremers, who proved, among other things, that sodium sulphate (common Glauber's salt), when crystallized at 158° F., showed the density 2.654, but when at 212° F., showed 2.684. Others have obtained it as low as 2.462 and 2.597 and as high as 2.73. Some years later, two French chemists, Favre and Valson, obtained similar and larger

variations with many other salts. As aforesaid, however, it is but very recently, but little before this present decade, that the general attention of chemists has been at all attracted to this subject; and there are still many who retain the ancient faith in the supposed accidental causes of variability of determinations of density of both elements and compounds, and in the inherence in every pure chemical body, or every admitted "polymer," of a characteristic and invariable density.

Evidence has been also introduced into this table to show that the true principle of universal "polymerism" is quite as marked in *liquid* as in solid bodies, so that it is not due to a mere change of mechanical structure. Organic bodies, of both liquid and solid forms, show it quite as plainly. Some gaseous and vaporous bodies probably show it also. But these must constitute future subjects.

"Polymerism" is a vague and wholly unsatisfactory term. It merely means "of many parts." The writer desires to displace it by the term *polysterism*, which means "of many volumes." This has a direct meaning and a direct application to this universal chemical law. There are, moreover, several kinds of polysteres; but this cannot be made clear till after the issue of some yet unpublished investigations of the writer.

TABLE

of the minimum and maximum densities of the best-known elements of matter; by Henry Wurtz, Ph.D.

1. Monads:		Densities.	
Sodium.....	min.....	0.9348	H. Davy, electrolytic.
	max.....	0.99	Kopp.
Potassium.....	min.....	0.84	Kopp.
	max.....	0.9766	Baumhauer.
Cesium.....	min.....	1.372	Setterberg.
	max.....	1.886	Setterberg.
Silver, ingot.....	min., slowly solidified.....	10.1053	Baudrimont.
	max.....	10.511	Holzmann.
Silver, wrought.....	min.....	10.4476	Baudrimont.
	max.....	10.5665	G. Rose.
Silver, melted.....	min.....	9.131	Playfair and Joule.
	max.....	10.002	Quincke.
Silver, native.....	min.....	10.38	siliform, Church.
	max.....	11.1	cited by Dana.
Copper, ingot.....	min.....	8.4525	slowly cooled, Baudrimont.
	max.....	8.958	electrolytic cast, Dick (Percy).
Copper, wrought.....	min.....	8.3912	wire, Baudrimont.
	max.....	8.9587	hammered, Berzelius.
Copper, melted.....	min.....	7.272	Playfair and Joule.
	max.....	8.217	Roberts and Wrightson.
Copper, native.....	min.....	8.838	Lake Superior, Whitney.
	max.....	8.932	Brazil, Marchand and Scheerer.
Gold, ingot.....	min.....	19.1	Kopp.
	max.....	19.4	Lewis.
Gold, wrought.....	min.....	19.207	hammered, Elliott.
	max.....	19.6	hammered, G. Rose.
Gold, precipitated.....	min.....	19.2981	precipitated by oxalic acid, G. Rose.
	max.....	20.6882	precipitated by green vitriol, G. Rose.
Gold, native.....	min., 2.54 per cent. silver.....	18.43	Forbes.
	40 " " ".....	18.77	Awdjew.
	3.58 " " ".....	18.79	Awdjew.
	40 " " ".....	18.89	Awdjew.
	1.76 " " ".....	18.95	Marsh.
	max., 0.16 " " ".....	19.099	Rose.
2. Dyads:			
Glucinum.....	min.....	1.64	Nilson and Petterson
	max.....	2.1	Debray.
Magnesium.....	min.....	1.69	Kopp.
	max.....	2.24	Playfair and Joule.
Calcium.....	min.....	1.55	Lies-Bodart and Jobin.
	max.....	1.8	Caron.
Zinc, ingot.....	min.....	6.861	Brisson.
	max.....	7.21	Daniell.
Zinc, melted.....	min.....	6.48	Roberts and Wrightson.
	max.....	6.9	Quincke.
Cadmium, ingot.....	min.....	8.45	Kopp.
	max.....	8.75	John.
Cadmium, wrought.....	min.....	8.667	Schroder.
	max.....	9.05	Children.
Cadmium, melted.....	min.....	7.969	Vincentini and Omodel.
	max.....	8.394	Quincke.
Mercury, liquid.....	min.....	13.535	Regnault.
	13.55	Muschenbroek.	
	13.584	Balfour Stewart.	
	13.603	Schiff.	
	13.613	Biddle.	
	min.....	14.0	Kupffer and Cavallo.
Mercury, frozen solid.....	14.1932	Mallet.	
	14.4	Regnault.	
	15.19	Joule.	
	max.....	15.745	Hallstrom.
3. Triads:			
Aluminum, cast.....	min.....	2.5	Wohler.
	2.56	Deville.	
	2.587	Langley.	
	max.....	2.6	Deville.
Aluminum, wrought.....	min.....	2.67	Wohler.
	max.....	2.8067	wire, Corbit.
Indium.....	min.....	7.11	Reich and Richter.
	max.....	7.421	Winkler.
Thallium, wire.....	min.....	11.808	De la Rive.
	max.....	11.91	Crookes.
4. Tetrads:			
Diamonds.....	min.....	3.334	North Carolina, Shepard.
	3.492	Grailich.	
	max.....	3.5	Berzelius.
Graphite, purified.....	min.....	1.802	Pelouze, also Brisson.
	max.....	2.26	Lowe.
Retort-carbon.....	min.....	1.835	Brodie.
	max.....	2.556	Mene.
Silicon, raphitoid.....	min.....	2.001	Meyn.
	max.....	2.493	Winkler.
Tin, ingot.....	min.....	7.239	Harmening.
	7.24	Deville, quickly cooled.	
	7.233	Schertel.	
	max.....	7.873	electrolytic cast, Miller.
Tin, wrought.....	min.....	7.292	Deville, slowly cooled.
	max.....	7.3775	Herapath.
Tin, melted.....	min.....	6.913	Spring, compressed.
	max.....	7.144	Baudrimont, wire.
Lead, ingot.....	min.....	11.1603	Playfair and Joule.
	11.225	Quincke.	
	11.33	Guyton de Morveau.	
	max.....	11.376	Deville.
Lead, wrought.....	min.....	11.388	Kopp.
	max.....	11.44	Mathiessen.
Lead, melted.....	min.....	11.445	Karsten.
	11.501	H. Rose.	
	10.37	Berzelius.	
	max.....	11.365	Reich.

5. *Pentads* :

	Densities.	
Antimony, ingot.....	{ min..... 6.6101, Breithaupt.	
	{ max..... 6.86, Bergmann.	
Antimony, melted.....	{ min..... 6.528, Quincke.	
	{ max..... 6.646, Playfair and Joule.	
Phosphorus, yellow.....	{ min..... 1.77, Berzelius.	
	{ max..... 2.09, Bottger.	
Phosphorus, melted.....	{ min..... 1.744, Playfair and Joule.	
	{ max..... 1.88, Schrotter.	
Phosphorus, amorphous....	{ min..... 1.964, Schrotter.	
	{ max..... 2.106, Schrotter.	
Phosphorus, metalloidal....	{ min..... 2.148, Troost and Hautefeuille.	
	{ max..... 2.34, Hittorf.	
Arsenic, solid.....	{ min..... 5.23, Playfair and Joule.	
	{ max..... 5.959, Guibourt.	
Bismuth, solid.....	{ min..... 9.8542, Karsten.	
	{ max..... 9.935, C. Deville.	
Bismuth, melted.....	{ min..... 9.709, Quincke.	
	{ max..... 10.055, Roberts and Wrightson.	

6. *Hexads* :

Sulphur, orthorhombic crystals.....	{ min..... 1.927, artificial crystals, Bischof.	
	{ 2.0477, native crystals, Spring.	
	{ 2.05001, native crystals, Karsten.	
	{ 2.0788, native crystals, Spring.	
	{ max..... 2.086, native crystals, Dumas and Roget.	
Sulphur, clinorhombic crystals.....	{ min..... 1.868, Bockmann.	
	{ max..... 2.072, Mohs.	

7. *Heptads* :

Manganese.....	{ min..... 6.85, Bergmann.	
	{ max..... 8.03, Buchmann.	

8. *Octads* :

Iridium, ingot.....	{ min..... 21.15, Deville and Debray.	
	{ max..... 22.38, Matthey.	
Platinum, ingot.....	{ min..... 19.5, Brisson.	
	{ max..... 21.5051, Deville and Debray.	
Platinum, wrought.....	{ min..... 20.3, Brisson.	
	{ max..... 22.069, Balfour Stewart.	
Platinum, sponge.....	{ min..... 15.78, Liebig.	
	{ 16.634, Rose.	
	{ 21.169, Playfair and Joule.	
	{ max..... 21.473, Thomson.	
Platinum, black.....	{ min..... 17.776, Playfair and Joule.	
	{ 20.7732, Rose.	
	{ 22.8926, Rose.	
	{ max..... 26.1408, Rose.	
Palladium, ingot.....	{ min..... 11.04, Cloud.	
	{ max..... 11.628, Zincken.	
Palladium, wrought.....	{ min..... 11.8, Wollaston.	
	{ max..... 12.148, Lowrey.	
	{ min..... 7.833, reduced by hydrogen and then cast.	Caron.
Iron, ingot, almost carbonless.....	{ 7.8707, by fusing soft iron with iron cast.	Percy.
	{ 7.822, (0.14 per cent. carbon), Koppmayer.	
	{ max..... 7.93, soft ingot, Elsner.	
Soft wrought iron, almost carbonless.....	{ min..... 7.6, wire, Baudrimont.	
	{ max..... 7.868, reduced by hydrogen and forged, Caron.	
Iron, precipitated from solution.....	{ min..... 7.5, precipitated by zinc, Pouquard.	
	{ max..... 8.1393, electrolytic, Smith (Percy).	
Iron, reduced by hydrogen.....	{ min..... 6.03, Stahlschmidt.	
	{ max..... 8.002, Schiff.	
Nickel, ingot.....	{ min..... 8.279, Richter.	
	{ max..... 9.0, Vauquelin and Hany.	
Nickel, wrought.....	{ min..... 8.58, Trautwine, rolled.	
	{ max..... 8.932, Tourte, forged.	
Nickel, reduced by hydrogen.....	{ min..... 7.803, Playfair and Joule.	
	{ max..... 9.261, Rammelsberg.	
Cobalt, ingot.....	{ min..... 8.39, Kopp.	
	{ max..... 9.152, Gehler.	
Cobalt, reduced by hydrogen.....	{ min..... 7.718, Playfair and Joule.	
	{ max..... 9.495, Rammelsberg.	

It is proper for me to acknowledge my indebtedness for a large proportion of the above figures to the magnificent Smithsonian Tables of Professor F. W. Clarke. Such figures have been carefully culled from this and from some other sources as would bring out most sharply the principles to be illustrated.

ANIMAL INTELLIGENCE.*

By JAS. WEIR, Jr., M.D.

"INTELLIGENCE is a conservative principle, and will always direct effort and use into lines which will be beneficial to its possessor."† This definition of intelligence is peculiarly applicable to the lower animals, inasmuch as it does not convey any idea of a purely intellectual operation of the mind. Every instance of ratiocination in the lower animals has its origin in the fundamental principle of benefit to the animal evincing this faculty of reason. The words reason and intelligence are, in a measure, synonymous, for without intelligence, reason cannot exist, and *vice versa*—without reason there can be no intelligence. They are both psychic factors, dependent each upon the other. The lower animals do not evince a high degree of intelligence, yet high enough to lift the mental operation above the automatic and spontaneous action generally called instinct. Instinct itself is, in a certain sense, a process of intelligence, though its immediate operations may not be due to reason. Instinct involves mental operations; if it did not, it would simply be reflex action. It is heredity under a special name. The father transmits his mental peculiarities as well as his corporeal individualities to his son. The experiences of thousands of years leave their imprint on the succeeding generations, until deductions and conclusions drawn from these experiences become in man that psychic essence called mind. The lower animals pass through a like experience and arrive, each in his own sphere and degree, at a kindred mental destination.

Reflex action is simply muscular adaptation excited by appropriate stimulation without mental cognizance. Instinct has always a mental element; and the lowest animal that lives is no more governed by reflex action than is man himself. The action of a spider spinning her web is just as voluntary and is as much under mental direction and control as the action of a carpenter building a house. That the very lowest forms of animal life give evidences of intelligence can no longer be denied. A very common rotifer whose body is cup-shaped and whose tail is armed with forceps has been seen to seize a larger specimen with its forceps, and thus attach itself to its cup. The larger rotifer immediately swung itself violently about until it met a piece of weed, this it seized with its forceps and began "the most extraordinary movements, which were obviously directed toward ridding itself of its incumbance." This it finally succeeded in doing, and the entire scene was so like intelligent action that the observer concludes "so that if we were to depend upon appearances

alone, this one observation would be sufficient to induce me to attribute conscious determination to these microscopical organisms."‡ Conscious determination and ratiocination is found in animals as low down in the scale of animal life as the rhizopoda. *Aethalia* will confine themselves to the water in a watch-glass in which they are placed, but when the glass is placed on sawdust, they will leave the water and go to the dust—their natural habitat.† These rhizopoda are content to remain in water, as long as there is no sawdust in their vicinity, but as soon as they recognize the sawdust *through the glass*, they crawl over the rim of the latter to get into a more pleasing abode. This is a wonderful example of conscious determination to be found in an organism so low in the scale of life. Once, while examining some fungal cells, Carter saw a still more wonderful instance of intelligence in a rhizopod. He noticed that one of the spore cells had ruptured and that grains of starch were escaping from the crevice. Suddenly an *actinophrys* came into the field of vision and proceeding to the ruptured cell seized a grain of starch and then retired to some distance. Presently it returned to the same cell and extracted another grain through the crevice. "All this was repeated several times, showing that the *actinophrys* knew that those were nutritious grains, that they were contained in this cell, and that, although each time after incepting a grain it went away to some distance, it knew how to find its way back to the cell again which furnished this nutriment."‡ Oysters taken from a bank never uncovered by the sea open their shells, lose the water within and soon die; but oysters kept in a reservoir and occasionally left uncovered, learn to keep their shells closed and live much longer when taken out of the water.§ This is an act of intelligence due directly to experience, without even the factor of heredity. It is an instance of almost immediate adaptation to surrounding circumstances. One would not expect to find examples of animal intelligence in such a low order as the *Helicida*, yet several instances can be adduced where snails have not only shown ratiocination but also have evinced love and affection.

A gentleman fixed a land snail, with the mouth of the shell upward, in a chink of a rock. The animal protruded its foot to the utmost extent and, attaching it above, tried to pull the shell vertically in a straight line. Then it stretched its body to the right side, pulled, and failed to move the shell. It then stretched its foot to the left side, pulled with all its strength and released the shell. There were intervals of rest between these several attempts, during which the snail remained quiescent.¶ Thus we see that it exerted force in three directions, never twice in the same direction, which fact proves conscious determination and no slight degree of intelligence. An observer, Mr. Lonsdale, placed two snails in a small and badly kept

garden. One of them was weak and poorly nourished, the other strong and well. The strong one disappeared and was traced by its slimy track over a wall into a neighboring garden where there was plenty of food. Mr. Lonsdale thought that it had deserted its mate, but it subsequently appeared and conducted its comrade over the wall into the bountiful food supply of the neighboring garden. It seemed to coax and assist its feeble companion when it lingered on the way.* Here we see not only an example of memory and discrimination, but also of affection and solicitude. After the snail had made its voyage of discovery, with rare unselfishness and true affection, it remembered its sick mate and returned for it.

Beneath the pavement in front of my door a wasp (*Vespa nigra*) has her nest. The entrance to this nest is at the bottom of a *sulcus* formed by two parallel bricks. I rolled a piece of paper into a compact wad and placed it between the bricks and over the entrance during her absence. When she returned she seized the paper with her jaws and forelegs and endeavored to pull it away. This was prevented by the interposition of the brick on which she stood. She then went to the other side and tried again. Here she failed for the same reason. She then descended into the little gully between the bricks and easily removed the wad. When she again left the nest, I replaced the paper, and on her return she went through the same performance as at first. Again I replaced it, but the *third time she went at once into the gully and removed the obstruction*. This she did three times in succession. Comment is hardly necessary. The evidences of memory and ratiocination are too patent to be denied. Some members of another family, distantly related to the *Helicida*, the limpets, show evidences of intelligence, inasmuch as they have a very accurate memory of direction. Limpets, when at rest, live at certain fixed domiciles. When hungry, they leave these homes in search of food, but invariably return to them as soon as they have satisfied their hunger. One very pointed instance of this homing sense is given by Hawkshaw, a most careful and exact observer. A limpet had made a clearing on a sea weed covered block of chalk. In the center of this clearing was a pedestal of flint which projected an inch or more. On the top of this flint pedestal the limpet had taken up its abode. The cleared space had several hollows where the animal could have easily sheltered itself, but it preferred to return to its exposed home after each of its excursions.†

Not many years ago, a French exhibitor with a trained company of fleas passed through the country. These insects had been taught to march and counter-march, to dance, to feign death, to pull miniature coaches, etc. While this does not evince voluntary ratiocination, it shows that fleas think and are capable of receiving instruction. "When we consider the habits of ants, their social relations, their large communities, and elaborate habitations, their roadways, their possession of domestic animals, and even, in some cases, of slaves, it must be admitted that they have a fair claim to rank next to man in the scale of intelligence."‡

When Lubbock says that the ant ranks next to man in the scale of intelligence he does not err. The superior intelligence of the ant has been recognized and commented on by man since the very inception of history. The wisest man of his day, King Solomon, uses the ant to point a moral. He considers her intelligence and industry worthy of emulation, and says to the sluggard: "Go to the ant, consider her ways and be wise." This one factor, intelligence, and the faculty of intercommunicating intelligently, makes a colony of ants a *perfect society*. Their social relations make it a model republic. Ants are true socialists; communists of an ideal type. There is a patriotism sublimely grand in its total self-abnegation. The commonwealth is everything—individual weal is not considered. Man is susceptible to individual attachments which form the basis of his happiness. The affection of ants, on the contrary, is a patriotism that is extended to the whole community, "never distinguishing individuals, unless, as in the instance of the communal mother, connected with the furtherance of the common good."§ Ants can undoubtedly communicate. A short while ago I crushed a pismire in the track usually taken by the members of a colony inhabiting the hollow of a beech tree standing in my yard. A soldier ant came along presently and, smelling the blood of his murdered companion, was seized with a panic terror, and rushed away into the nest. He shortly returned with thirteen companions and made a slow and careful reconnaissance of the dead body and its surroundings. Then all of them examined the corpse, and, having satisfied themselves that their sister was dead, returned to the nest. In a few moments a large worker ant, accompanied by two soldier ants, came out, and, proceeding to the body, picked it up and carried it down the tree to the ground. They then went beneath the grass and I lost sight of them. Their every action seemed to me to be governed by an almost human intelligence. The discoverer of the murder hurried into town, gave the alarm, and, quickly gathering some of his companions, went out in search of the murderer. On discovering that their companion was dead and her slayer absent, they came back to town and sent out a burial party.

The ant is the only animal except man which has slaves and domestic animals. Their intelligence is so highly developed that they make a perfect success in rearing their cattle and in capturing their slaves. The cattle of the ants are of the order *Aphidida*. The herdsmen of these aphidian cattle can be seen patrolling the shrubs on which the aphides are grazing. On them devolves the care of the herds. They bring them out in the morning and carry them back at night. They gather the eggs of the aphides, carry them into a specially built nursery, attend them carefully until the young aphides are hatched out, and then carry them to the shrubs most liked by them for food. Some strange sense enables them to recognize one another—an ant of the same species, but coming from another nest, is immediately recognized as a

* Romanes: "Animal Intelligence," p. 18.

† H. J. Carter: "Annals of Natural History."

‡ Ibid.

§ Dicquemare: *Journal de Physique*, vol. xxviii., p. 244.

¶ White: "A Londoner's Walk to Edinburgh," p. 155.

* Darwin: "Descent of Man," pp. 262-3.

† Hawkshaw: *Journal Linn. Soc.*, vol. xiv., p. 406.

‡ Lubbock: "Ants, Bees, and Wasps," p. 1.

§ Kirby and Spence: *Entomology*, "Perfect Society."

* From the *American Naturalist*.

† Cope: "Origin of the Fittest," p. 40.