acid and pyridine or whatever the unknown quantities may prove to be.

Returning to the camphor-producing animal, it may be noted that *Polyzonium* is a circumpolar genus and is represented in Europe by *P. germanicum*, with which our American form is closely related if not identical. That the nature of the secretion should have remained undiscovered is not suprising in view of the fact that the animal is small (15 by 2 mm.) and of very retiring habits, affecting only the humus of moist, undisturbed forest regions. Moreover it has a very peculiar appearance and would generally be taken for a worm or a small slug rather than for a myriapod, and may not give off its repugnatorial secretion unless injured. Taxonomically it is looked upon as the type of a distinct family, Polyzonidæ, also of a suborder, Polyzonoidea, in which it is, however, associated with a tropical family, Siphonotidæ. With two other suborders also consisting of few genera and few and local species, but having a wide general distribution, the order Colobognatha is made up. This has been found to differ* from other diplopods, not only in the possession of many primitive characters, but in having the copulatory legs not truly homologous, a very reliable indication of long separation in evolutionary history. Of course this is no reason for supposing that *Polyzonium* has preserved the ancestral type of repugnatorial secretion, particularly in view of the fact that camphor is a much more complex substance than prussic acid. That the biological affinity is thus remote, may, however, encourage the chemists by providing all the time necessary for any succession of reactions they may see fit to predicate.

O. F. COOK.

WASHINGTON, D. C.

* "A new Character in the Colobognatha, with drawings of Siphonotus," *Ameriean Naturalist*, Oct. 1896, xxx, 839–844.

PROGRESS IN METEOROLOGICAL KITE FLYING.

THE value of the kite in meteorological research is now universally recognized. As a result of improvements in apparatus and methods successively greater heights have been reached until within the past fifteen months, 4300 meters or higher has been reached by Teisserenc de Bort, in France, while at Blue Hill Observatory in this country, 4,850 meters was attained on July 19, 1900. This last height is greater than that of any American balloon ascension where accurate observations were made. Since meteorological kite flying may be said to have begun practically within the past seven years, it is improbable that the limits of maximum height or of efficient work have been reached; for as yet but few individuals or institutions have undertaken such work on an adequate scale.

The work at Blue Hill during the past year indicates that improvement may be expected (1) as a result of further modifying the kite and (2) from experiments to determine the size of wire best adapted for use as line.

The original Hargrave kite with flat lifting surfaces usually attained an angular altitude of 54° to 56° when flown from a short line. The addition of an intermediate lifting surface in the front cell possibly increased this average altitude to 58° or 59° but rendered the kite unstable. In winds of 15 meters per second, or higher, the flat surfaced kites are driven downward by the increase of pressure upon the front edges of the cells, high flights being possible only during favorable conditions. By the addition of rigid curved sustaining surfaces the altitude reached by the best kites is now about 66°, and the average of several kites is about 64°. The effect of wind pressure on the edges of the cells does not seriously affect the altitude until the velocity of the

wind exceeds 20 meters per second (true velocity).

When the kite flies at an altitude of 65° its vertical height is about 90 per cent. of the length of the flying line. Greater efficiency is desirable, but at these steep altitudes the kite is not always easily or safely managed when near the ground, especially in variable winds, or when the kite is being reeled in. In the latter case any slight pull upon the line brings the kite beyond the zenith, where it becomes unstable and difficult to handle safely. Refinements in construction may probably remove this defect, but at present it does not seem likely that any great improvement in stability or efficiency may be expected very soon. It is very desirable to know what form of curve for the lifting surfaces is most efficient, also if a lighter, stronger and more easily built frame may be developed.

At present, kites strong enough to withstand winds of 20 to 30 meters per second or higher require a velocity of 5 meters per second or higher to lift them with the meteorograph; and since the larger kites are heavier per unit area than the smaller ones it does not seem desirable to construct kites having an area exceeding 9 square meters. Moreover, such large kites are difficult to handle in high winds.

Steel music wire remains the best material for line, although efforts have been made without success to obtain material of greater tensile strength. At the beginning of the use of wire at Blue Hill, in 1896, it seemed best to use a small wire, since the smaller wires are slightly stronger, weight for weight, than the larger; and with the exception of a short piece of No. 11 wire purchased for trial, No. 14 wire alone was employed until February, 1900, when 7000 meters of No. 17 wire were obtained. Tests of the three sizes of wire showed that when the smallest wire was employed, the limit of safe working strain was reached before the angular altitude of the kites became as high as that reached when the largest wire was employed, although the larger wires were appreciably heavier for the same strength than the smaller. To determine, if possible, the size of wire best adapted for use, the tensile strengths and weights of all sizes of music wire larger than No. 10 were obtained from two leading manufacturers, and are given in the accompanying table. The data from the different sources did not agree exactly and the figures in the table are averages.

DIAMETER, WEIGHT AND TENSILE STRENGTH OF MUSIC WIRE USEFUL AS KITE LINE.

Music Wire Gauge Number.	Diameter (in Millimeters).	Weight of 1000 Meters (in Kilograms).	Tensile Strength (in Kilograms).
10	.61	2.16	85
11	.66	2.60	97
12	.71	3.08	113
13	.76	3.56	126
14	.81	4.00	140
15	.86	4.52	148
16	.91	5.00	162
17	.97	5.71	178
18	1.02	6.37	189
19	1.07	6.94	203
20	1.12	7.46	223
21	1.17	8.33	236
22	1.22	9.09	256
23	1.29	10.00	281
24	1.40	11.48	311
25	1.50	13.51	350
26	1.60	15.63	402
27	1.70	17.54	450
28	1.80	20.00	533
29	1.88	22.22	590
30	1.98	24.39	657

A careful examination of all the data shows that the cause of the greater efficiency of the larger wires is that they present relatively less surface to the wind than do the smaller; and that, instead of being an insignificant effect, as some have supposed, the pressure of the wind upon the wire is a most important one. The surface of a No. 17 wire presented to the wind is nearly one square meter for each thousand meters of length; and since, in very high flights 8,000 to 12,000 meters of wire are in

the air, the total pressure of the wind must be very great and its tendency is always to drive the wire and kites to a lower altitude. Wind pressures of 30 to 50 kilograms per square meter of surface exposed normally to the wind are not uncommon, and it appears that the line presenting the smallest surface, relative to weight, is the one best to employ. Considering the wire alone, there is an advantage in using the largest size of wire, but there appears to be a practical limit to the number of kites that may be efficiently employed on one line. At Blue Hill, at present, the average number of kites employed at one time is six—three large and three small—having a total lifting surface of less than 30 square meters. Since it is not desirable to increase the size of the kites, the increased power required to lift a larger wire must be derived from a number of the largest kites now used; and since more than eight kites can seldom be used to advantage, it appears that a No. 25 or a No. 26 wire will give the best results, until there can be obtained better kites capable of lifting a larger wire. It is also probable that a line made up of several different sizes of wire may be more efficient than one of uniform size.

The present maximum height (4,850 meters) in all probability is not the highest attainable with No. 17 wire, and while it is unsafe to predict the result of future experiment, it now seems likely that, with a stronger line and kites of greatest efficiency, heights exceeding 6,000 meters are within reach. Moreover, flights to elevations of 4,000 meters or higher could be made more quickly and easily than at present.

S. P. FERGUSSON.

BLUE HILL OBSERVATORY,
September 12, 1900.

SCIENTIFIC BOOKS.

THE PUBLICATIONS OF THE VOLTA BUREAU.

WHILE the Volta Bureau was founded, by Alexander Graham Bell, 'for the increase and diffusion of knowledge relating to the deaf,' with a philanthropic desire to promote their welfare, the publications of the bureau will interest students in many departments of science, and the purpose of this review is to call attention to some of the general bearings of two of these publications.

I. *The Helen Keller Souvenir* (2) Commemorating the Harvard Final Examination for Radcliffe College, June, 1899. By A. GRAHAM BELL, ANNIE M. SULLIVAN, and others.

It is less remarkable that Helen Keller, who was born blind as well as deaf, has passed the examinations for admission to Harvard University, '*with credit in advanced Latin*': than that she has become so familiar with the use of language that she finds no more difficulty in the work of the college class-room than any other bright student.

The way in which this result has been reached, in the face of such difficulties, should be studied by all teachers, not only for their encouragement, but because they will find in it an illustration of the requisites which are essential for all successful instruction.

Her first teacher, Miss Sullivan, speaking of her at the age of twelve, or thereabouts, says that while her accomplishments seem marvelous to many, they "consist *only* in her being able to speak and write the language of her country with greater ease and fluency than the average seeing and hearing child of her age." Miss Sullivan asks whether we may not hope for similar results with children who are so fortunate as to have eyes and ears with which to see and hear, and all who are familiar with the lamentable failure of a common school education to give command of the English language must feel an interest in the answer.

Helen Keller was not *taught* the use of language. She was put into the way to discover its meaning, and was left to make the discovery for herself, as every normal child does, and as we find out everything else that is worth knowing. But while normal children make this discovery at too early an age to be able to tell us about it, Helen did not make it until she had enough maturity of mind to reflect upon it, and enough natural knowledge to know her need of it, and to understand its value.