TABLE I.
Effects of 2% beta-naphthoxyacetic acid upon sunflower, zinnia, and tomato. (Results given as percentage of plants affected.)

Effects noted	Sunflower	Zinnia	Tomato
Stunted growth	100	100	97
Branching	45	53	25
Distorted leaves	100	100	100
Disturbed phyllotaxy	84	88	86
Fusion of leaves or of leaf segments	89	90	88
Fusion of primordia	75	89	83
Displaced primordia	70	74	70
Splitting of apex	25	33	30
Fasciation	30	34	30

malformed leaf primordia are also produced. The effects of alpha-naphthoxyacetic acid and of beta-naphthoxyacetic acid are similar to the effects of colchicine, but usually less pronounced. The beta form is more potent than the alpha, and since little has been published concerning its action on plants a figure and table are here introduced to describe it.

In general, beta-naphthoxyacetic acid and the other chemicals used in this study are found to produce results upon primordial plant tissues similar to the effects of X-radiation.

11230 P

Droplet Infection of Air: High-speed Photography of Droplet Production by Sneezing.*

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The question of infection of air by droplets given off in coughing and sneezing has received considerable attention during the last few years. In particular, investigation has been directed towards determining the rôle of the air-borne droplet nuclei which result from the evaporation of droplets proper. The bacteriological and epidemiological aspects have recently been discussed by Wells, Wells, and Mudd.[1] Experimentally, little is known of certain of the characteristics of such droplets—their number, size, velocity, settling rate, and rate of

* Contribution No. 163 from the Department of Biology and Public Health.

1 Wells, W. F., Wells, W. W., and Mudd, S., *Am. J. Pub. Health*, 1939, **29**, 863.

evaporation—although these factors are concerned in their dissemination and the production of droplet nuclei. Wells[2] has calculated theoretical settling times and distances of fall before evaporation, for plain water droplets of various sizes suspended in still air of different humidities. These figures are only roughly applicable to actual conditions of air infection, since mouth spray and naso-pharynx droplets will contain some dissolved solids or be mucus-like, and the air will not be still. Rooks[3] has shown experimentally that droplet size is an important factor in nasal filtration, although he knew only the theoretical *differences* in average size of the droplets with which he worked. Weyrauch and Rzymkowski[4] have photographed the *tracks* of moving droplets given off in sneezing and talking. The paths shown indicate that most of the actual droplets travel only relatively short horizontal distances.

We have been able, by means of high-speed photography, to "stop" the motion of droplets given off in coughing and sneezing, thereby permitting measurements of droplet size, velocity, etc. The technic utilizes the light source and control instruments developed by Edgerton, *et al.*,[5] for stroboscopic illumination and high-speed photography. The light source, which is placed at one side of the subject's face, consists of a 9-inch specular reflector with a spiral argon-filled tube through which a 56 microfarad condenser (charged to 2500 volts) discharges. An intense flash of short duration is produced, illuminating the droplets with a dark-field effect so that they stand out sharply even in daylight. The photographically effective duration of flash (exposure time) may be adjusted to the velocity of the particles whose motion is to be stopped. An electrical contact on the camera shutter synchronizes the flash with the shutter motion.

Figure 1 shows the result of a sneeze, at the end of the "downstroke" of the head. Most of the droplets have already been expelled; of these, some 4600 may be counted which were in the focal plane of the camera. This photograph was taken with an ordinary camera on 9 x 12 cm film, with an *f*11 aperture, and an exposure of 1/15,000 of a second. In spite of this short exposure, below the nose may be seen the paths of droplets which moved during that time. (Electrical characteristics of the light source account for the "reversed head and tail" appearance of these particle paths.) Calcula-

2 Wells, W. F., *Am. J. Hyg.*, 1934, **20**, 611.

3 Rooks, R., *Am. J. Hyg.*, 1939, **30**, 7.

4 Weyrauch, F., and Rzymkowski, J., *Z. f. Hyg. u. Infektionskr.*, 1938, **120**, 444.

5 Edgerton, H. E., Germeshausen, K. J., and Grier, H. E., *J. Appl. Physics*, 1937, **8**, 2.

FIG. 1.

Droplets resulting from a sneeze. Instantaneous photograph (exposure 1/15,000 of a second) taken at the end of the "down-stroke" of the head. Note tracks of moving particles beneath the nose, and the string of saliva issuing from the mouth.

tion shows the fastest of these droplets to be moving at a rate of over 100 feet per second. Such a velocity, in dry air, would result in nearly instantaneous evaporation, producing droplet nuclei. The significance of the velocity of expulsion in relation to evaporation is perhaps greater than has been appreciated; it would appear to be a more important factor than settling velocity.

As regards droplet size, optical considerations indicate that only those in sharp focus give photographic images approximating the *true* particle size. The range of *apparent* diameter of the great majority of sneeze droplets, before appreciable evaporation occurs, has been determined from photographic enlargements to be 1/10 to 2 mm, which figures are probably maximum rather than minimum diameters.

We have observed that the involuntary closing of the mouth near the end of a sneeze tends to produce more and smaller droplets, which probably come largely from the saliva in the front of the mouth. Also, the number of droplets issuing from the nose is usually insignificant compared with the number expelled from the mouth. These observa-

tions may be important in relation to infectivity, because of the differences in the microbic flora of the two regions.

Problems of rates of and distances to evaporation, and of minimum droplet size are being investigated.

11231 P

Effect of Repeated Injections of Cobra Venom on Blood Chemistry and Morphology.

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Large doses of cobra venom were repeatedly injected in rabbits for periods varying from 2 to 21 weeks, and quantitative studies were made on the morphology and chemistry of their blood. The venom solution was usually injected 5 times a week and the dosage administered on injection varied from 5 to 10 mouse units. Inasmuch as 5 mouse units constitute the usual therapeutic dose of cobra venom for human beings and 10 mouse units are employed only in more refractory cases, the dosages given rabbits in the present study were manifestly enormous. The results obtained from 10 rabbits are reported in this investigation. Three of the rabbits were used as controls and received no cobra venom while the other 7 received the drug partly by the intravenous and partly by the intramuscular route. Rabbits of different weight were purposely selected at the beginning of the research but all were kept under the same conditions and fed with Purina Chow supplemented with fresh green vegetables. The cobra venom solution (H. W. & D.) employed was prepared in these laboratories and assayed by the authors on white mice by methods described elsewhere.[1] This solution is the same as that employed by various authors in clinical studies published in different journals.[2-6] Crude cobra venom consists largely of neurotoxin and contains relatively small quantities of cytotoxic and proteolytic constituents in striking

[1] Macht, *Proc. Nat. Acad. Sc.*, 1936, **22**, 61.

[2] Macht, *Med. Rec.*, 1936, **144**, 537.

[3] Macht, *Ann. Int. Med.*, 1938, **11**, 1824.

[4] Gayle and Williams, *Southern M. J.*, 1938, **31**, 188.

[5] Rutherford, *New England J. Med.*, 1939, **221**, 408.

[6] Black, *Southern M. J.*, 1940,