populations while the interrelationships between hosts and parasites provide valuable aid in the understanding of insect behaviour. In protecting crops and domestic animals from their pests, both insect and weed, the method of controlling the latter by means of their natural enemies is coming to the fore every day but the very complex problems involved make it essential to study and thoroughly understand the parasite in relation to its hosts and environments. Few groups of insects seem destined to be more important than those collectively grouped as parasites.

ACKNOWLEDGMENT

The manuscript of this paper has been kindly read through by Dr. Hem Singh Pruthi, Imperial Entomologist, and my thanks are due to him for his very helpful criticism on several points.

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Nicotine and Citric Acid Content in the Progeny of the Allopolyploid Hybrid *Nicotiana rustica* L. × *N. glauca* Grah.

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ALLOPOLYPLOID di-*rustica*—di-*glauca* originated by chromosome duplication in the first generation of the hybrid *Nicotiana rustica* ($n = 24$) × *N. glauca* ($n = 12$).[1] It had 72 somatic chromosomes and was partially fertile and dwarf in size, while the F_1-hybrid developed normally and was self-sterile.[1] In studying the procedure of the meiotic processes in the allopolyploid di-*rustica*—di-*glauca* hybrid, I found quite often the appearance of multivalent chromosomes (quadrivalents and trivalents with univalents) during the first meiosis due to auto- and allosyndesis. I shall mention here that allosyndesis between *glauca* and *rustica* chromosomes was also observed in the F_1-hybrids which formed a variable number of bivalents (sometimes until 12), some of them being heteromorphic. The appearance of univalents and rarely one bivalent in *N. rustica* ($n = 24$) haploid[2] indicates that bivalents in F_1-*rustica* × *glauca* result from allosyndetic pairing, *i.e.*, from chiasma formation between *N. rustica* (r) and *N. glauca* (g) chromosomes.

Allo- and autosyndetic chiasmata (r—r—g—g) of the multivalents formed among *N. glauca* and *N. rustica* chromosomes in the allopolyploid di-*rustica*—di-*glauca* are responsible for the formation of unequal gametes. The inconsistency, *i.e.*, the segregations in the subsequent generations of this allopolyploid is consequently due to the exchange of parts between *N. rustica* and *N. glauca* chromosomes in the multivalent groups as it was clearly shown for the allopolyploid *N. glauca*—*Langsdorffii*.[3]

The progeny of the dwarf allopolyploid *N. rustica-glauca* differed enormously in respect to their morphological, physiological and biochemical characters. In the second, third and fourth allopolyploid generation (A_2, A_3, A_4) there were dwarfs (about 40 cm.), giants (about 250 cm.), and all transitional degrees between these two extremes. Similar amplitudes of variations were observed in the leaf sizes and shapes, the flower sizes and shapes and the vegetation periods, the latter and the length of the petioles showing even a transgressive segregation in respect to those of the parental forms. There were segregates that developed very rapidly and formed a larger amount of green mass (leaves and stems), than the parental species *N. glauca* and *N. rustica*. A more detailed description of their morphology and cytogenetic behaviour will be given elsewhere. I shall call attention here to the alkaloid and citric acid content of some plants of the fourth generation (A_4) of the allopolyploid di-*rustica*—di-*glauca*, grown in 1937.†

The data given in Table I show that the original species *N. rustica* contains alkaloid, nicotine, while the other parental species both alkaloids, nicotine and anabasine. The studies by the collaborators of the Tobacco Institute[4] showed that in species crosses when one of them has nicotine, and the other anabasine, F_1-hybrids contain—as a rule—anabasine. The behaviour of the

TABLE I

Alkaloid and citric acid contents of the amphidiploid, Nicotiana rustica × N. glauca *and of the original species*

No.	Plants	Alkaloid content: per cent.			Citric acid content per cent.
		Nicotine	Anabasine	Total alkaloid content per cent.	
1	*Nicotiana rustica*	2·059	0	2·059	5·595
2	*Nicotiana glauca*	0	0·837	0·837	3·036
	Amphidiploid plants				
	N. rustica × *N. glauca*				
3	75006 — 1	0	1·423	1·423	2·428
4	75006 — 100	0	1·232	1·232	—*
5	75006 — 101	—	—	—	4·967
6	75006 — 102	—	—	—	3·025
7	75006 — 103	0	0·971	0·971	4·679
8	75006 — 104	0	1·449	1·449	3·263
9	75006 — 105	0	1·182	1·182	4·397
10	75006 — 106	0	1·088	1·088	3·572
11	75006 — 107	0	1·395	1·395	4·447
12	75006 — 108	0·093	0·509	0·602	2·937
13	75006 — 109	0	0·753	0·753	3·431
14	75006 — 111	0	1·204	1·204	3·529
15	75006 — A	0	1·386	1·386	1·319
16	75006 — B	0	1·986	1·986	1·675
17	75006 — E	—	—	—	2·081

* — Denotes undetermined.

N. glauca and all allopolyploids contain alkaloid anabasine with a single exception, namely plant No. 75006–108, which contains progeny of our allopolyploid confirms this rule. In crossing F_1 – *N. rustica* × *N. glauca* back to *N. rustica* and selfing the back crosses I obtained very abundant material which was given to N. I. Zhukov for further study. I grew in 1937 a few families of it and the results of the chemical analysis of

† The determination of the citric acid and alkaloid contents were carried out in the Biochemical Laboratory of the Institute of Genetics under the direction of Prof. A. A. Schmuck for whom I wish to express my gratitude.

some plants are given in Table II. The data show that they contain both alkaloids, nicotine and anabasine. Large number of analyses carried out by Zhukov (in the press and unpublished) upon the same material during two generations showed that plants having anabasine segregate into (1) plants with anabasine and (2) plants with both anabasine and nicotine, while plants having both anabasine and nicotine never give rise to plants only with anabasine. Such a behaviour of the alkaloids suggests that the allopolyploid No. 75006—108 is a segregate resulting from crossing-over between *glauca* and *rustica* chromosomes carrying the gene or genes that are involved in the formation of the alkaloids. This question will be thoroughly discussed elsewhere.

TABLE II

Alkaloid and citric acid contents in some plants of the $F_{3/4}$ *generation of the back-cross* (N. rustica × N. glauca) × N. rustica

No.	$F_{3/4}$ of the back-cross (*N. rustica* × *glauca*) × *N. rustica*	Nicotine per cent.	Anabasine per cent.	Total alkaloid content per cent.	Citric acid per cent.
1	75115 — 1	0·927	0·403	1·330	—*
2	75133 c — 2	—	—	—	2·554
3	75133 c — 3	0·654	0·648	1·302	4·856
4	75133 c — 5	1·140	0·502	1·642	5·118
5	75133 c — 6	0·645	0·718	1·363	—
6	75134 c — 1	—	—	—	3·964
7	*Nicotiana glauca*	0	0·837	0·837	3·036
8	*Nicotana rustica*	2·059	0	2·059	5·595

* — denotes undetermined.

A *N. rustica*-like segregate from the back cross (*N. rustica* × *N. glauca*) × *N. rustica* contained only anabasine without nicotine. *This is a case when biochemical character is transmitted from one species on the background of another one following interspecific hybridization.*

In studying the citric acid content (the plants contain it in form of salts) in the allopolyploid segregates (Table I) it was found that they have very different contents of this substance, although they grew under identical environmental conditions together with the parental species. Segregate No. 75006–A had, for example, 1·319 per cent. citric acid, segregate No. 75006—101 had 4·967 per cent., while the parental forms had, *N. rustica* 5·595 per cent. and *N. glauca* 3·036 per cent.

Allopolyploid *N. rustica-glauca* is an interesting plant from the agricultural point of view, because it segregates forms with larger amount of anabasine (1·986, 1·449, 1·395 per cent., etc.) than the parental species *N. glauca* which, when grown in the same environmental conditions, contained only 0·837 per cent. At the same time the offsprings contain a relatively large amount of citric acid. Further generations of some of the offsprings should give the possibility of selecting forms with larger content of anabasine and citric acid. The populations produced from the back-crosses can be used for the same purpose. It should be also mentioned here that anabasine content can be increased about three times after decapitation as the analysis by Zhukov has shown.

Alkaloid anabasine is one of the most important insecticides. It is being produced now from the *Anabasis aphylla* which grows wild. This plant contains about 1·3–2·0 per cent. anabasine. Young parts of the plant contain up to 2·53 per cent. anabasine, but the production of anabasine from *A. aphylla* is insufficient to cover the requirements of this chemical. Some of the allopolyploid segregates, on the other hand, grow very rapidly and give a very large amount of green mass when grown in suitable environmental conditions.

Considering all these facts, I think that our allopolyploid *N. rustica*—*N. glauca,* as well as the back-crosses and other hybrids between *N. rustica* and *N. glauca* that are studied now in the All-Union Tobacco Institute by N. I. Zhukov might answer the demands of the industry in a short time if the plant-breeding work with these plants is put on a somewhat larger scale.

I shall also mention here that most of the allopolyploid segregates are from perennial plants like *N. glauca,* and the annual parent, *N. rustica.* In autumn 1938, when the temperature dropped at night to $-5°$ C., the leaves of *N. glauca* were severely injured, but the plants were not killed. The same reaction occurred with most of the allopolyploid segregates. A few segregates were, however, less injured than *N. glauca* plant. A single segregate was not affected by $-5°$ C. All *N. rustica* plants were killed by a temperature of $-3°$ C. Amphidiploids *N. rustica* × *tabacum* and *N. glauca* × *Langsdorffii* behaved in a similar way. Autotetraploid plants of *Solanum Lycopersicum* were also more resistant to cold than their diploid forms. Preliminary observations show that a series of polyploid plants are more cold-resistant than their original diploids. This new character permits the polyploid forms to occupy more nordic areas than their original diploids. It seems very probable that polyploidy will help the plant breeders to move some of the existing cultivated varieties and even some forest plants towards more nordic regions by doubling their chromosome numbers.

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OBITUARY

Ravindra Nath Misra (1912–38)

On the 9th of December 1938, a tragic accident removed from our midst Ravindra Nath Misra, Research Fellow in Botany in the University of Lucknow. Mr. Misra died of burns received by the bursting on him of a flask of alcohol which caught fire while he was trying to light a spirit lamp. He passed away very young, when he was hardly twenty-six and was beginning to carve out for himself a brilliant career in botanical research. Only a few days before his death he was awarded the *Ruchi Ram Sahni Prize* for 1938 for the best research work in Botany.

Ravindra Nath Misra

Mr. Misra became Research Scholar on obtaining his M.Sc. degree in 1936. By himself and in collaboration with Dr. S. K. Pande, he carried out investigations on the liver-worts of this country. He was collaborating with Dr. Pande in the production of a series of monographs—"Studies in Indian Hepaticæ".

Mr. Misra had a tremendous love for mountaineering. He organised several expeditions from the Botany Department of the Lucknow University to far off places in the Himalayas and brought back with him valuable plant collections.

It is difficult to believe that a promising career like his could be cut short so cruelly and with such gasping suddenness. As a man, he had rare qualities: frank, straightforward and untouched by mannerisms. His is a loss to Indian Botany, not only on account of what he could achieve during his butterfly existence, but also because of what he would have achieved if he had been spared. Among his friends he has left a void which cannot easily be filled.

RAJENDRA VARMA SITHOLEY.