Orchard Network Crab Apple Project
"Will the real *Malus sylvestris* please stand up?"
THE CRAB NEWSLETTER: APRIL 2023

Orchard Network is a partnership of organisations working together for the conservation of orchards across the British Isles.
To see Orchard Network (www.orchardnetwork.org.uk)

The Crab Apple Project objective is to record tree, leaf, flower and fruit morphology, other fruit characteristics, and DNA fingerprints, of a range of wild crab, hybrid and feral apple trees in natural locations in the British Isles:

1. **to see if this helps to identify native *Malus sylvestris trees* and separate them from *M domestica,* and from wild/feral hybrids with *M domestica* (and other *Malus* species).**
2. **to provide, if possible, a field identification method to separate the native *Malus sylvestris* from hybrids (and we recognize that many before us have already tried!)**
3. **evaluate the fruit of both the species and its hybrids for apple and cider apple breeding – not least to pass on its relatively disease-free character to cider apples.**

PROGRESS OF THE PROJECT

Spring 2022

The funding for this national project is a grant provided by City of London, which owns open access land around London, including Epping Forest, Burnham Beeches, Ashtead and Hampsted Heaths and other commons, that have many crab apple trees. The funding primarily provides funding for DNA fingerprinting of up to 350 tree samples over 3 years, and some expenses. During the design and planning before project in 2021, some 15 crab apple trees from Dorset and Suffolk (where the two members of Orchard Network that planned the project live) were DNA fingerprinted in preparation, and this data and their morphological data is now joined by the 2022 surveyed trees in our data spreadsheets.

Highlights of 2022 were In early May this year the project team and a group of surveyors met at City of London's Burnham Beeches to try out the Spring Survey Form on their crab apple trees, and discuss issues relating to crab apple identity. In May for flowers, and September and October for fruit, surveyors recorded data for crab apple trees apple trees across England and senttheir data and photographs in for compilation to Suffolk.

103 trees were surveyed in late April and May and their morphology recorded from 16 localities across England, by over 30 surveyors. From the spring surveys sent in, 45 trees with a wide diversity of flower and/or foliage morphology were selected for DNA analysis: surveyors gathered leaves and sent them to EMR (East Malling Research) in June for freezing to await analysis. DNA analysis results were sent to us in December 2022.

Autumn 2022

We requested surveyors to survey the same trees they surveyed this spring and Autumn Survey Forms, concentrating on the fruit in, were sent to surveyors in time for a September to late October survey of the fruit. This combined information gives us the first full overview of the range of morphology of the trees being surveyed. Of the over 103 trees surveyed in Spring, we removed 6 trees from the survey as they were either large and clearly *M domestica* apples or were red-flowered ornamental Malus species. However of the 97 remaining, only 60 trees were surveyed in the autumn, fewer than hoped, and these will need to be surveyed in autumn this year in order to be include in the survey. This does include a number of trees that we have DNA fingerprinted.

An important part of this project was always that we would have **data from both seasons of the same trees** and we hoped that by the end of 2022 we would have the morphology from over 100 trees, and be able to look at different aspects, even different DNA analyses, as needed.

We are on track for this as long as surveyors return to the trees they have already surveyed just once in 2022 to complete two season's data.

THE PROJECT IN 2023

The table below:

1. **Lists the trees in batches, by surveyor**, not as a name (thank GDPR for that!), but as a **Surveyor Code No**, the broad location of the trees, and the number of trees surveyed in 2022, to assist a surveyor to recognize her/his/your data. If data *doesn't* help you decide, please email Paul for your Code No., paul@home-farm.myzen.co.uk,

2. **Columns indicate the number of trees each surveyor surveyed in 2022, by season, spring and autumn**, **and the number of trees that were surveyed in both seasons.** The GREEN numbers column show completed surveys, the RED request column lists the 2023 surveys we hope Surveyors will be able to carry out on trees this year, 2023, and in the season to complete the target for that tree. (Some of you reported very poor flowering. Several trees were also reported to have dropped their entire crop in the summer drought!)

3. **Our target is to complete the two surveys on all the trees started in 2022**, **for at least 100 trees**. So far 60 trees have completed morphology surveys for both seasons.

4. **44 trees of these listed trees have now been DNA finger printed**, but not all these have been fully surveyed, and miss one season of surveying. We hope that they will have been by this autumn.

5. **DNA fingerprinting this year 2023, as last year, will be carried out on leaves collected this June** so new trees will only have been surveyed in May and sent in to us with little time to decide whether to DNA or not.

Code no	General location	Surveyed 2022		Completed tree surveys	Potential with full morph data by end 2023	Tree surveyor ACTION requested 2023	No of trees DNA'd		
		Spring tree nos	Autumn tree nos				In 2021	In 2022	Planned 2023
1	Glos	13	14	13	14	1 spring survey		7	TBA
2	Surrey 1 (Ashtead)		3		3	3 spring surveys		2	TBA
3	Middx (Barnet)	1				None, not *Malus*			TBA
4	W Yorks	4	4	4	4	Add new trees?			TBA
5	Suffolk 3 (East S)		1		1	1 spring survey		1	TBA
6	Essex	4			4	4 spring surveys			TBA
7	I of Wight	5	5	5	5	Help to open files			TBA
8	NC Suffolk 2		3		3	3 spring surveys			TBA
9	Middx (Hampstead H)	7	7	7	7	Add new trees?		7	TBA
11	Surrey 2	1			1	1 autumn survey			TBA
12	Wilts 1	3	1	2	3	2 spring surveys			TBA
13	Worcs (starting 2023)				n	Add new trees?			TBA
14	Notts/Sherwood	6	4	4	6	2 spring surveys		2	TBA
15	Staffs (starting 2023)	n	n		n	Add new trees?			TBA
16	Bucks 1 (Burnham B)	8	14	8	14	6 spring surveys		8	TBA
17	Herefordshire		6		6	6 spring surveys			TBA
18	Surrey3 (Wisley) (2023)				n	3 spring & autumn			TBA
19	Northants	2			2	2 spring surveys			TBA
20	Dorset/Somerset	16			16	16 autumn surveys	8	8	TBA
21	London 2	8			uncertain	8 autumn surveys			TBA
22	Suffolk 1 (Mid S)	10	10	10	15	+ 5 new trees	3	7	TBA
23	Wilts 2	5	5	5	5	Add new trees?			TBA
24	Cambs/Northants	3	2	2	3	1 autumn survey		2	TBA
25	Surrey 4	1			1	1 autumn survey			TBA
26	Kent 1		1			None =*domestica*			TBA
27	Kent 2		1		1	1 spring survey			TBA
	Nos of Trees	**97**	**81**	**60**	**114**		**11**	**44**	**0**

The project has, nominally, 2 years to run, taking us to spring 2025, but it is now clear that we won't have our morphology data on 100 trees until this autumn 2023, and won't have the DNA data on those trees until about December 2023, leaving only just over a year to evaluate the full data records for all 100 trees. We have the full two-season morphology details for 60 of the trees, with some gaps where a season's data is missing. Other surveyors will start this spring, so we aim to circulate a full table of results later this year.

SPRING 2023, SURVEY FORMS FOR SURVEYORS

The flowering season this spring may be slightly later than usual and slightly later than last years. Records of specific cvs flowering in Kent (at the NFC) and here is Suffolk suggest early plum cvs were a week later than average. This delay may not be maintained as the spring moves on but we could expect apples flowering in May could be a few days later than last year. In Suffolk last year's peak crab apple flowering was about 7th May, about 1 week later than average peak flowering of apple/M domsetica cvs, which can be spread over almost a month.

Survey forms will be sent out in a few days to all surveyors, with instructions and a list of photographs required, for trees NOT surveyed last spring, and for new trees that you are sure you will be able to survey again this autumn.

Last year we prepared a survey sheet file that could be printed and completed as a hard copy and then scanned for emailing. it could also be completed as Word file, although this option wasn't used much. The scanned paper version worked very well. However, we had proposals from surveyors that would have preferred an Excel file format, also better for us use for our final compilation. and we used Excel for the autumn survey form. We now recognize that this may not have suited everyone, so this year we have two alternative formats for both seasons, the original print-out style, to print out, complete and scan, as used last year, and an Excel format.

AUTUMN 2023, SURVEY FORMS FOR SURVEYORS

This survey form will be the same as last year, sent out this summer, and also in a print out, complete and scan format.

2023 DNA FINGERPRINT SCHEME

We hope to analyse over 60 trees this year. As with last year, once I receive the emailed spring 2023 trees survey forms and photographs, we will decide what trees we need to DNA Fingerprint. We will email you with the full details, and envelops for despatch will be sent to you, for you to mail to the analytical organization **by the end of June**. Other than sending to a different address this will be a repeat of last year's scheme.

WHAT NEXT?

Once we have the basic data, morphological and DNA, from a wide range of M sylvestris hybrids and domestica etc we will consider how we should analyse it. We may also add data from FruitId's extensive DNA data base of M domestica cvs and hybrids, and data from other tree collections and sources. All this will be principle subject matter in the next Newsletter!

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An example of a narrow white petal, with a narrow petal insertion. A feature recorded in our survey. Associated with small fruit?

SOME ITEMS OF INTEREST FROM ONCA SURVEYS IN 2022, AND OTHER *MALUS* INVESTIGATIONS

BURNHAM BEECHES CRAB APPLE TREE SURVEYS

Burnham Beeches, Bucks, a common owned by City of London Corporation since the 19th C has extensive grazed wood pasture with many crab apple trees, The team there have extended their tree survey beyond simply completing our survey form, using the 8 trees data from multiple leaves and fruit as well as the DNA analyses. With specialist help they have carried out bivariate analyses producing scattergrams for these variables....we hope to feature their report in the next ONCA Newsletter.

DEFINITELY NOT A CRAB! ... IN SUFFOLK

The autumn data was just as revealing and diverse as the spring data, mentioned in our ONCA Spring Newsletter.

A good example is a tree on my (Paul Read's) survey list.

This two-trunked monster, below, is one of a scatter of "crab apple" trees on Wortham Ling, Suffolk, an isolated veteran on open common heathland. In spring its white blossom stands out, and it was always on my list to survey. The spring survey recorded the flowers as definitely pink tinged in bud, slightly overlapping petals, although with narrow petal insertion, so I mentally scored it as a hybrid. Visited again in late Sept for the autumn survey I didn't expect the bright red crop! It could one of Mr Kidd's, a New Zealand's top apple breeder of the 1920's, cultivars! PR

THE IDENTITY OF *MALUS SYLVESTRIS*

For some years before the ONCA project objective was first drafted in 2019 there have been repeated statements that it is not possible to identify *M sylvestris* without using genetic analysis, but this remains our objective for ONCA, even if it is to identify trees that are **not** *M sylvestris.* EUFORGEN, www.euforgen.org, European forest genetic resources programme, cites other European tree species that because of introgression (cross breeding with other closely related species) this could apply to: Black Poplar, *Populus nigra*, Wild pear (*Pyrus pyraster/communis*) as well as "wild apple" (*Malus sylvestris*) (and likely others are genus *Prunus* and willows, *Salix* species). However, what is becoming clear, and mentioned in Euforgen papers and elsewhere, is that it may be possible to define what is *not* the original *M sylvestris* species from morphological details, thereby illuminating the hybrids; for example hybrids with *Malus domestica could be inferred from* fruit size, fruit colour, and surface pattern.

A range of fruit from **HOME FARM**

In this collection of crab apples from a site in Suffolk, all four round the outside could be inferred as hybrids from either their large fruit size, fruit colour, coloured stripes or dots, or surface texture (russet).

ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT!

The OECD "*is a unique forum where the governments of 37 democracies with market-based economies collaborate to develop policy standards to promote sustainable economic growth*". It also conerns itself, very widely indeed, in all thing related to apples including....its Consensus Documents

"*The OECD biosafety consensus documents identify elements of scientific information used in the environmental safety and risk assessment of transgenic organisms which are common to OECD member countries*."

For reasons that are not clear to me that includes *M sylvestris* . This is the CONSENSUS in full:

Fruit colour OECD paper on Consensus of Apples domestication

The domestication of Malus occurred around 8 000 to 2 000 BCE in Central Asia, possibly near Almaty, Kazakhstan (Vavilov,1930 as referred to in Robinson et al., 2001; Zohary, Hopf and Weiss, 2012). Apple seeds and trees from selected forms were then dispersed along the trade routes of the Silk Route from Central Asia, east to People's Republic of China and west to Europe (Harris, Robinson and Juniper, 2002), resulting into random establishment of apple germplasm along the Silk Route (see Figure 4). Hybridisations occurred between the apples coming from central Asia and closely related species present along the Silk Route. This gave rise to diverse forms of hybrids from which the present day cultivated apple might have been selected and propagated by vegetative means. Several species contributed to the genetic background of the current apple populations, some of the ones that are considered to have contributed are the Siberian crab apple M. baccata L. (Borkh.), the Caucasian crab apple M. orientalis Uglitzk., and the European crab apple M. sylvestris L. Mill. (Cornille et al., 2012). The wild European crab apple M. sylvestris, in particular, is considered to be a major contributor to M. domestica in Western Europe, as it is genetically more closely related to this species than to its Central Asian progenitor, M. sieversii (Cornille et al., 2012, 2014; Duan et al., 2017).

THE SCOTTISH WILD APPLE PROJECT (LEAD BY EDINBURGH BOTANIC GARDEN)

The most recent investigation into *Malus sylvestris* in the UK has been the fascinating and invaluable Scottish work published in two papers in 2018:

Ruhsam M., Jessop, W., Cornille, A., Renny, J. and Worrell, R. 2018. Crop-to-wild introgression in the European crab apple Malus sylvestris in Scotland and Northern England. Forestry, 2018

Crop-to-wild introgression in the European wild apple Malus sylvestris in Northern Britain | Forestry: An International Journal of Forest Research | Oxford Academic (oup.com) British Wildlife also carried a summary of this article.

And

Worrell R, Ruhsam M, Renny J, Jessop W and Findlay G. The Ecology and Genetics of Scotland's Native Wild Apple: Malus sylvestris. Forest Enterprise Scotland. See ecology-and-genetics-of-scotlandas-native-wild-apple-malus-sylvestris_finalv3.pdf (scottishforestrytrust.org.uk)

Most of the trees surveyed were located from national and local botanical records of Malus sylvestris, and large old trees were clearly preferred. The trees were recorded for morphological characters including leaf hairiness but the project found no reason to consider leaf hairiness a useful species separator (PR private communication). The trees were DNA fingerprinted and the data analysed (using two established genetic software packages) indicating that some specific trees had a high probability of being pure *M sylvestris*

Since then this further paper has been published:

Markus Ruhsam, James Renny, Rick Worrell 22 November 2022, *Verification of wild apple (Malus sylvestris) nursery stock sold in the United Kingdom*.Verification of wild apple (Malus sylvestris) nursery stock sold in the United Kingdom - Ruhsam - 2023 - PLANTS, PEOPLE, PLANET - Wiley Online Library

This paper compared the data analysis results of the DNA data of nursery stock on the UK market with the data from their trees designated as pure M sylvestris, as defined in the previous paper.

LEAF HAIRINESS STUDIES IN EAST ANGLIA

We are aware that at least one diagnostic character we have been recording, may have less significance than we had originally expected. This is the issue of leaf hairiness. Glabrous/hairless leaves has been widely stated as a diagnostic specific to *Malus sylvestris*, separating that species from *domestica* which has downy/hairy leaves, especially leaf undersides, but also from hybrids.

During our surveys in 2022 the leaves of crabs, *Malus* species, cultivars and hybrids were recorded using the x10 hand lenses in use by many surveyors, and also in Suffolk with a x20 and x50 dissecting microscope. In spring every leaf viewed had some hairs, often in local patches, especially close to the leaf base as the leaves unfurled, and retained a degree of downiness on the under-side that diminished as the season progressed... in some cases to just downiness left only on the underside leaf veins. The loss of hairs over the season does, as has been widely stated, seem to be due to wind/weather wear, with the largest changes noticeable on large *domestica* leaves.

The trees used for this study were the "crab apples" surveyed for this project in Suffolk, crop apple cvs from a traditional orchard in Suffolk, crop apple cvs in an ornamental *Malus* collection in the NFC at Brogdale, Kent, in May and late Sept and some purely ornamental species and cvs at the National Malus Collection at Barnard's Farm, West Horndon, Essex in May. Only a few autumn cases of recordable glabrous leaves were found in the field with a hand lens, but in every case these revealed downy underside leaf veins under the microscope in autumn; all these were either large fruited (more than 40mm dia) or highly coloured fruit cvs, and all these were in the NFC's *ornamental* collection.

Exactly where and when this emphasis on glabrous leaves as defining our native *M sylvestris* originates seems to be a mystery. Early floras, up to and including Clapham, Tutin and Warburg 2nd Ed 1962, accept *Malus sylvestris* as the species embracing both wild native crab (as ssp *sylvestris)* and domesticated apples (as ssp *mitis*), and does not separate them by leaf hairiness, but by flower calyx/sepal hairiness. Stace, the recent flora, states *sylvestris* as "leaf glabrous only when mature", and separates it from *domestica* only on fruit size (small) and colour (green).

Glabrous leaves do not appear to be considered to be a diagnostic in European flora literature, at least those searched.

Paul Read
14 April 2023

RIGHT: Surveyors (and Paul) and a crab apple tree, Burnham Beeches, May 2022.

LEFT: Estimating the age of a section of a crab apple tree from Burnham Beeches. This was the base of branch blown from a veteran stump, with extensive rot holes from which beetle frass, probably Noble Chafer (*Gnorimus nobilis*), was taken in May 2022. Noble Chafer was trapped locally two years earlier.
Trunk estimated at 90-120 years.