

# **Gamma algorithms report**

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## Executive Summary:

This report analyzes different algorithms focused on differentiating among *Chrysina kalinini*, *C. resplendens* and *C. cupreomarginata* species. These algorithms will analyze a particular spectrum and will produce a number. That index is going to be averaged and a boxplot will be made for each species. This information can be used in the future to analyze unknown spectra and make a guess of the most probable identity for a sample.

## Specimen Information:

The following collections were used: CICIMAUCR3

Number of specimens per species:

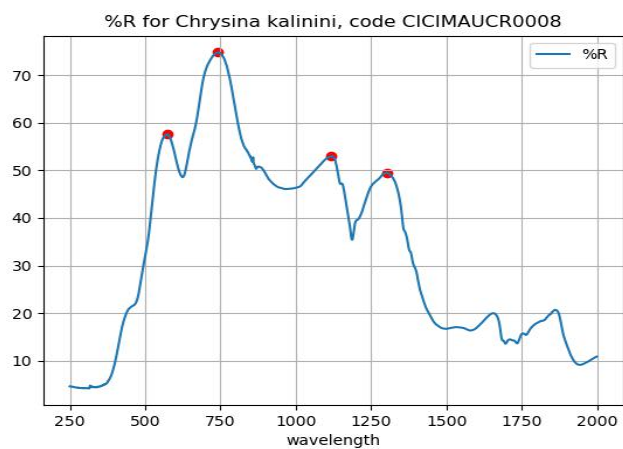
cupreomarginata	kalinini	resplendens
7	8	10

## Relevant data:

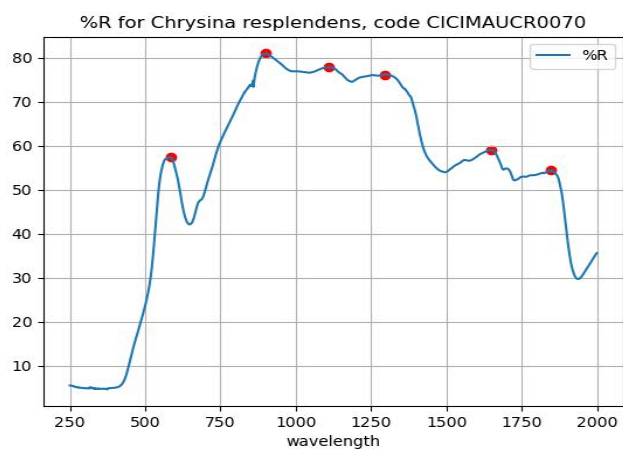
code	genus	species	measuring_mode
CICIMAUCR0008	Chrysina	kalinini	%R
CICIMAUCR0070	Chrysina	resplendens	%R
CICIMAUCR0019	Chrysina	cupreomarginata	%R
CICIMAUCR0100	Chrysina	cupreomarginata	%R
CICIMAUCR0009	Chrysina	kalinini	%R
CICIMAUCR0006	Chrysina	kalinini	%R
CICIMAUCR0098	Chrysina	cupreomarginata	%R
CICIMAUCR0158	Chrysina	cupreomarginata	%R
CICIMAUCR0141	Chrysina	kalinini	%R
CICIMAUCR0013	Chrysina	resplendens	%R
CICIMAUCR0014	Chrysina	cupreomarginata	%R
CICIMAUCR0101	Chrysina	resplendens	%R
CICIMAUCR0020	Chrysina	resplendens	%R
CICIMAUCR0001	Chrysina	kalinini	%R
CICIMAUCR0012	Chrysina	cupreomarginata	%R
CICIMAUCR0112	Chrysina	resplendens	%R

CICIMAUCR0104	Chrysina	resplendens	%R
CICIMAUCR0116	Chrysina	kalinini	%R
CICIMAUCR0021	Chrysina	resplendens	%R
CICIMAUCR0113	Chrysina	kalinini	%R
CICIMAUCR0015	Chrysina	resplendens	%R
CICIMAUCR0097	Chrysina	kalinini	%R
CICIMAUCR0071	Chrysina	resplendens	%R
CICIMAUCR0018	Chrysina	cupreomarginata	%R
CICIMAUCR0108	Chrysina	resplendens	%R

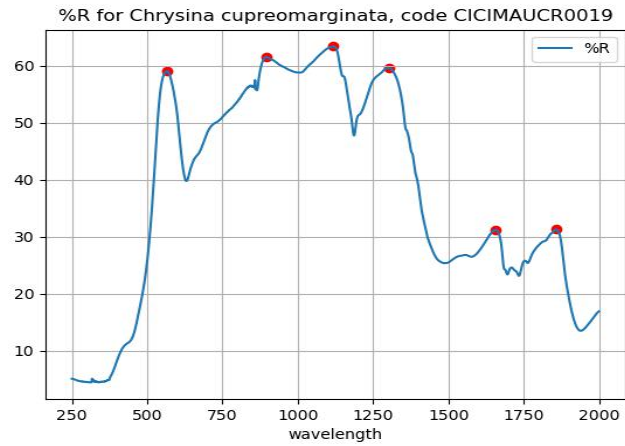
## Spectral information :



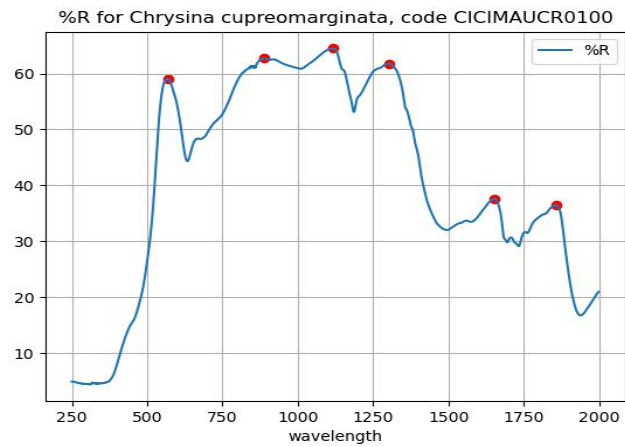
Peaks: [(573.0, 57.565073), (742.0, 74.750457), (1118.0, 52.9868), (1304.0, 49.434433)]



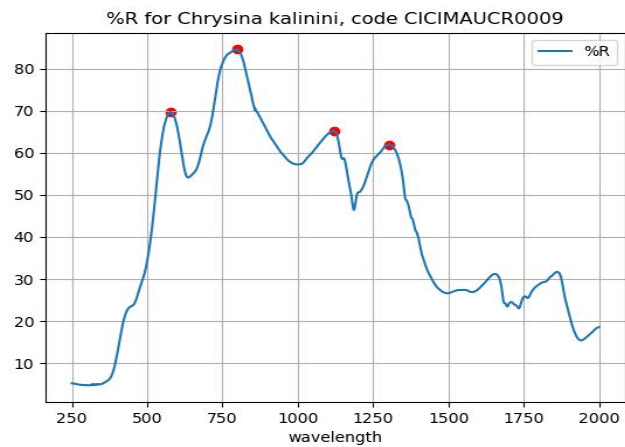
Peaks: [(584.0, 57.416235), (900.0, 80.9879), (1108.0, 77.821467), (1297.0, 76.182033), (1648.0, 59.012233), (1847.0, 54.4288)]



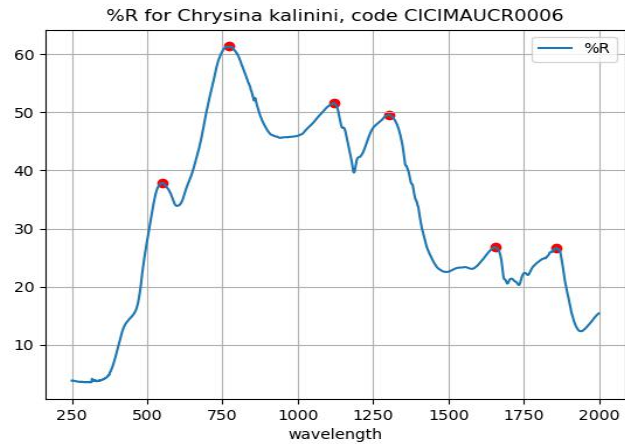
Peaks: [(566.0, 59.022762), (894.0, 61.529), (1118.0, 63.377225), (1301.0, 59.60595), (1655.0, 31.208625), (1857.0, 31.2811)]



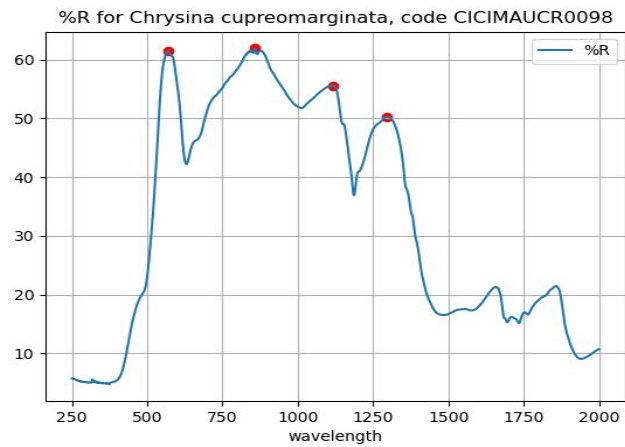
Peaks: [(570.0, 59.046779), (887.0, 62.695667), (1118.0, 64.496), (1302.0, 61.772267), (1651.0, 37.6115), (1857.0, 36.493667)]



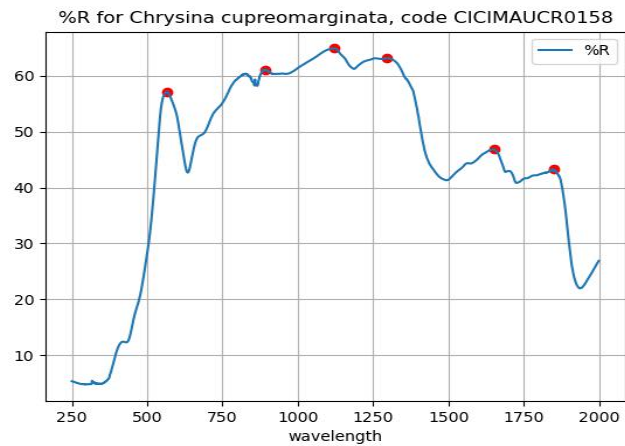
Peaks: [(577.0, 69.666709), (797.0, 84.574415), (1119.0, 65.221267), (1304.0, 61.962967)]



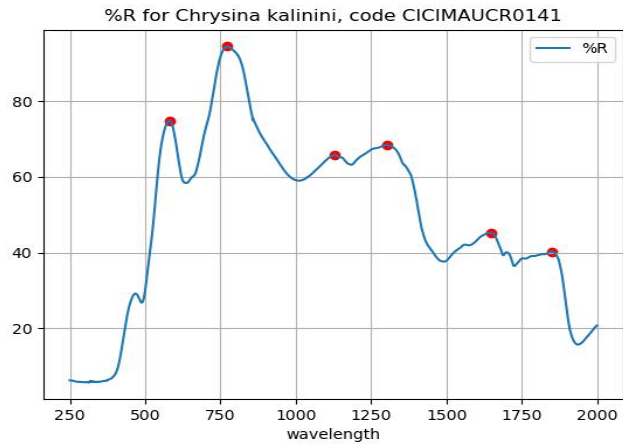
Peaks: [(550.0, 37.871428), (772.0, 61.37373), (1119.0, 51.588067), (1303.0, 49.532067), (1654.0, 26.7769), (1858.0, 26.644867)]



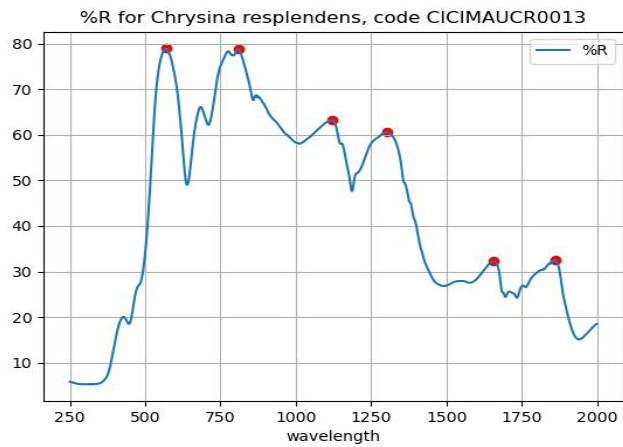
Peaks: [(568.0, 61.440618), (858.0, 61.921867), (1117.0, 55.568967), (1295.0, 50.300567)]



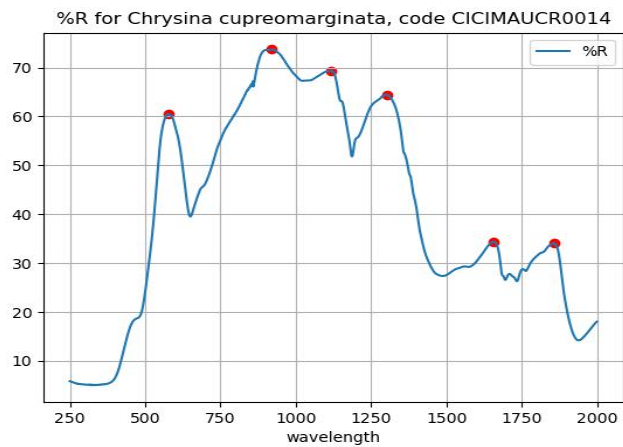
Peaks: [(566.0, 57.159646), (890.0, 61.155725), (1119.0, 64.938), (1296.0, 63.194525), (1651.0, 46.8466), (1848.0, 43.2865)]



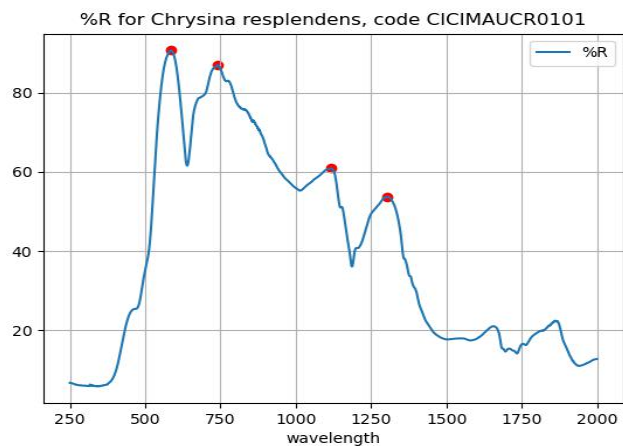
Peaks: [(580.0, 74.927905), (773.0, 94.569538), (1129.0, 65.8094), (1302.0, 68.464533), (1647.0, 45.238), (1849.0, 40.276267)]



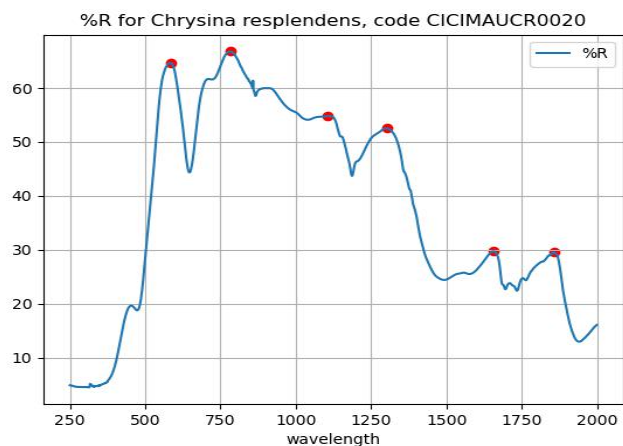
Peaks: [(568.0, 78.927183), (809.0, 78.759525), (1119.0, 63.202667), (1303.0, 60.598), (1656.0, 32.246233), (1860.0, 32.5331)]



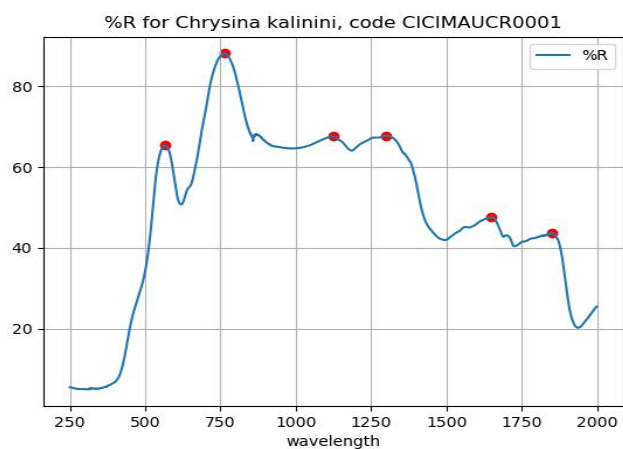
Peaks: [(577.0, 60.467787), (917.0, 73.7078), (1117.0, 69.3332), (1301.0, 64.4236), (1656.0, 34.3696), (1857.0, 34.105467)]



Peaks: [(585.0, 90.643824), (741.0, 86.892313), (1117.0, 60.844733), (1304.0, 53.7168)]

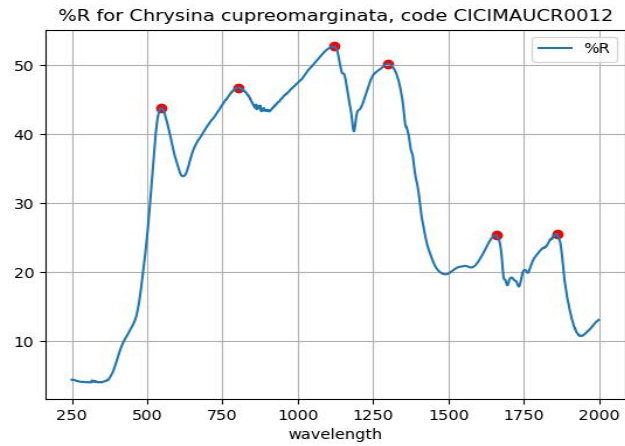


Peaks: [(585.0, 64.678125), (784.0, 66.787822), (1107.0, 54.7888), (1302.0, 52.52872), (1656.0, 29.72922), (1858.0, 29.57326)]

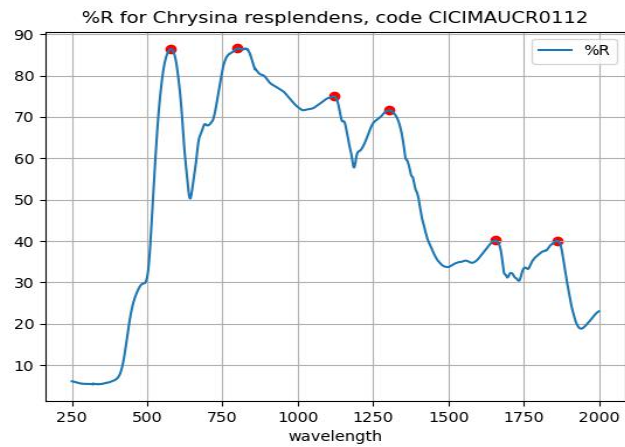


Peaks: [(567.0, 65.361779), (765.0, 88.156557), (1123.0, 67.663), (1300.0, 67.7368), (1649.0, 47.5637), (1848.0, 43.790775)]

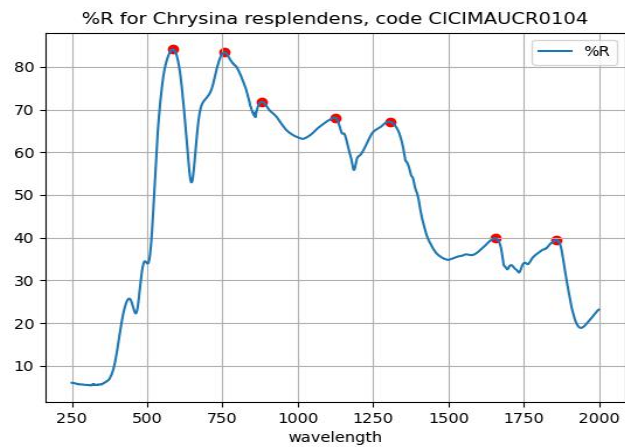




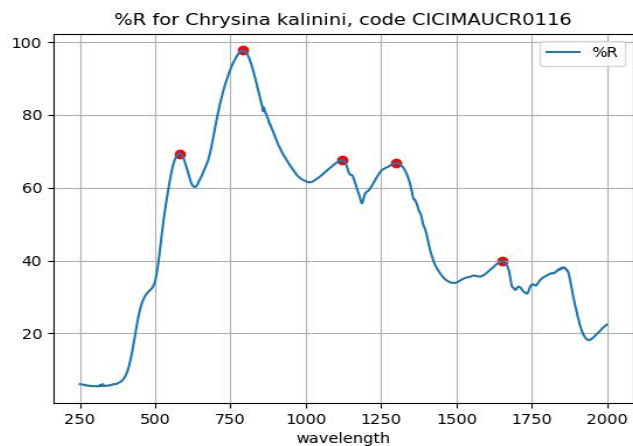
Peaks: [(546.0, 43.788362), (804.0, 46.713055), (1119.0, 52.704367), (1298.0, 50.181533), (1658.0, 25.3587), (1860.0, 25.5469)]



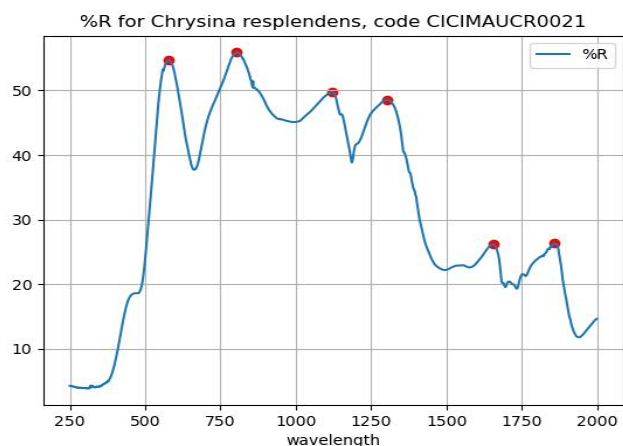
Peaks: [(579.0, 86.413042), (800.0, 86.556177), (1119.0, 74.9452), (1304.0, 71.5834), (1655.0, 40.184267), (1860.0, 40.134833)]



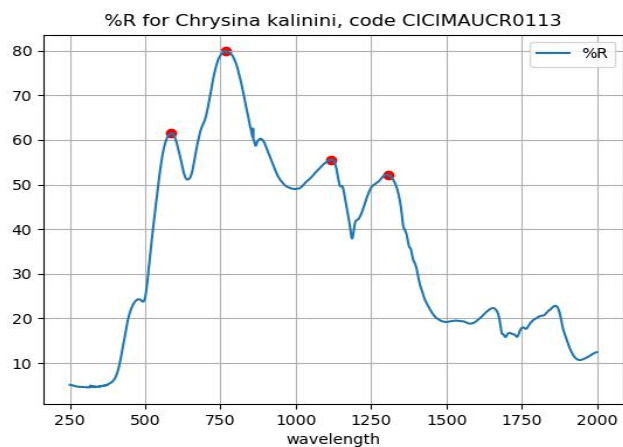
Peaks: [(586.0, 84.065535), (756.0, 83.368833), (881.0, 71.811433), (1123.0, 68.127033), (1305.0, 67.133867), (1654.0, 39.885667), (1857.0, 39.461367)]



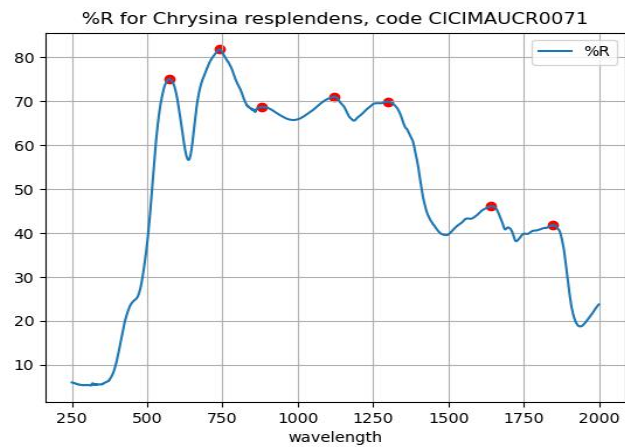
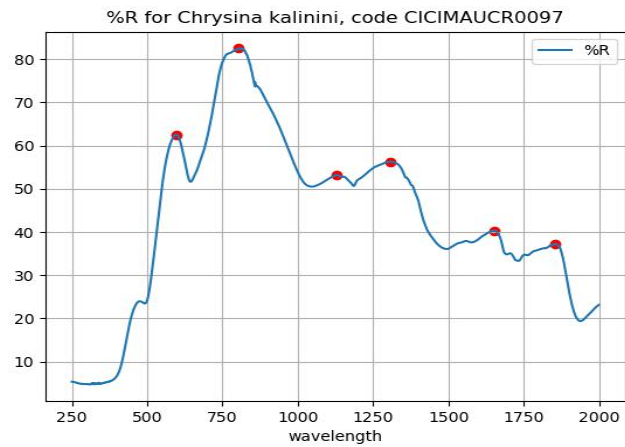
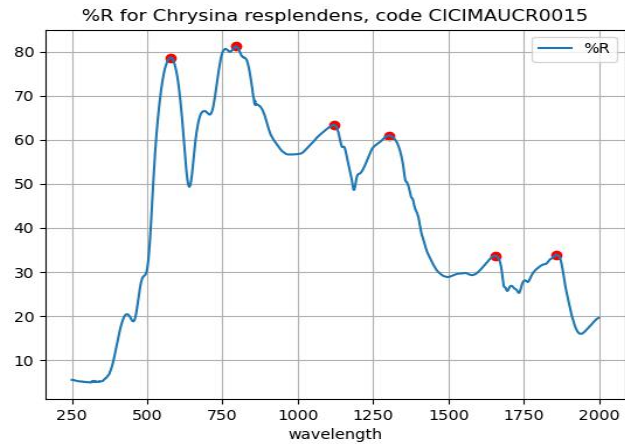
Peaks: [(581.0, 69.376085), (790.0, 97.701462), (1122.0, 67.594867), (1299.0, 66.780167), (1653.0, 39.8064)]

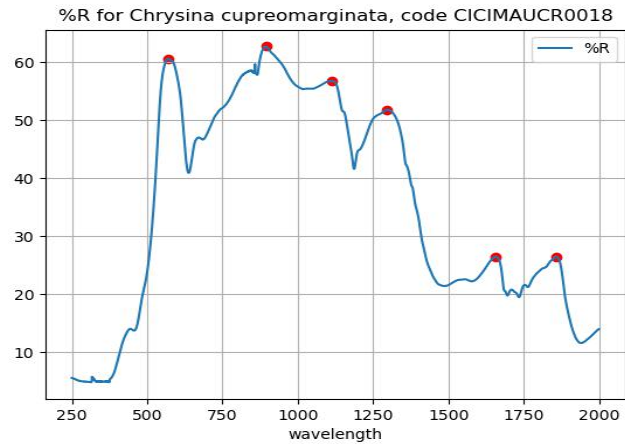


Peaks: [(577.0, 54.679584), (803.0, 55.885959), (1121.0, 49.750833), (1303.0, 48.560033), (1654.0, 26.187667), (1858.0, 26.319733)]

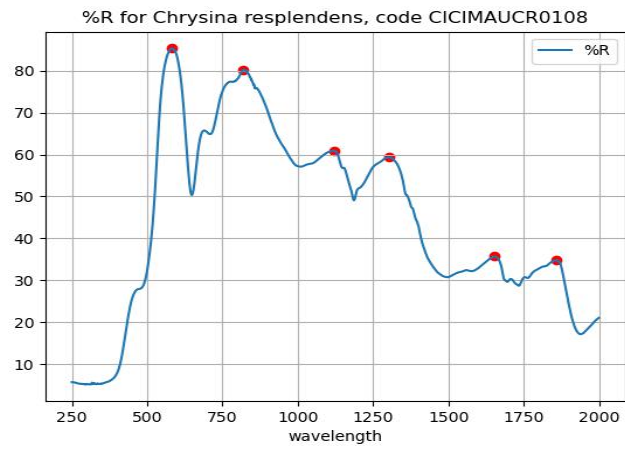


Peaks: [(587.0, 61.504072), (769.0, 79.835077), (1118.0, 55.593967), (1305.0, 52.172333)]





Peaks: [(569.0, 60.598799), (894.0, 62.712325), (1112.0, 56.7179), (1295.0, 51.78175), (1656.0, 26.503475), (1858.0, 26.48465)]



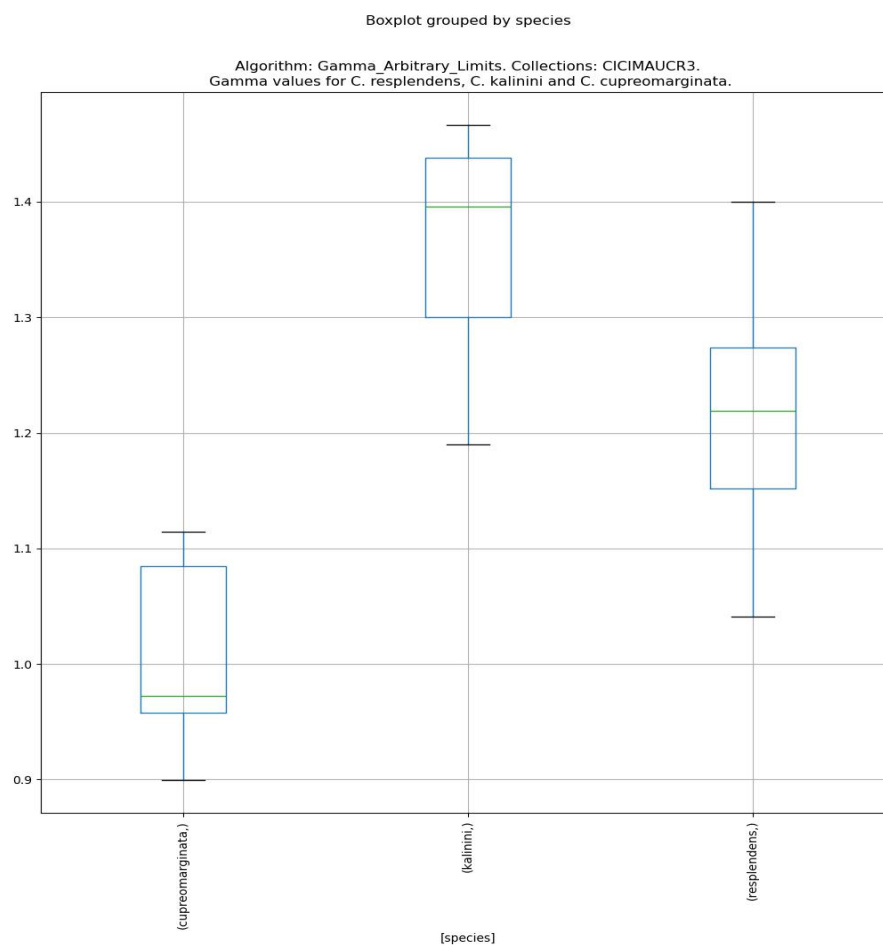
Peaks: [(582.0, 85.318426), (820.0, 80.225809), (1119.0, 60.949967), (1302.0, 59.333567), (1653.0, 35.683633), (1857.0, 34.827833)]

## Algorithm description: Gamma\_Arbitrary\_Limits

This algorithm calculates the ratio between the highest reflectance peak in the visible range (Between 250.0 nm and 1000.0 nm) and the maximum peak in the IR range up to 2500.0 nm. Beyond 2500.0 nm the internal structure's reflectance generates unwanted noise.

## Results

### Gamma boxplot for Gamma\_Arbitrary\_Limits



***Differentiable species:***

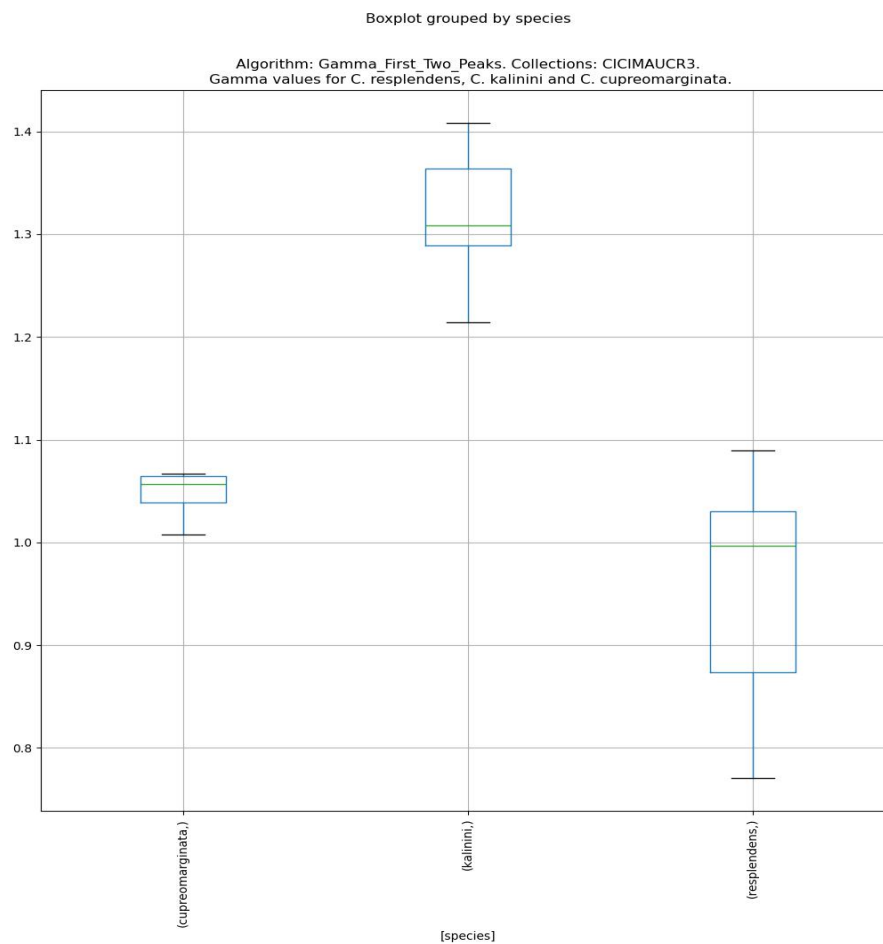
Assuming each species is distributed normally: Differentiable species are: ['kalinini', 'resplendens', 'cupreomarginata']. 75.0% of these specimens will be found in a region in which the probability of being a specimen of other species is less than 25.0 %.

## Algorithm description: Gamma\_First\_Two\_Peaks

This algorithm calculates the ratio between the second and first reflectance peak.

## Results

### Gamma boxplot for Gamma\_First\_Two\_Peaks



***Differentiable species:***

Assuming each species is distributed normally: Differentiable species are: ['kalinini', 'resplendens', 'cupreomarginata']. 75.0% of these specimens will be found in a region in which the probability of being a specimen of other species is less than 25.0 %.

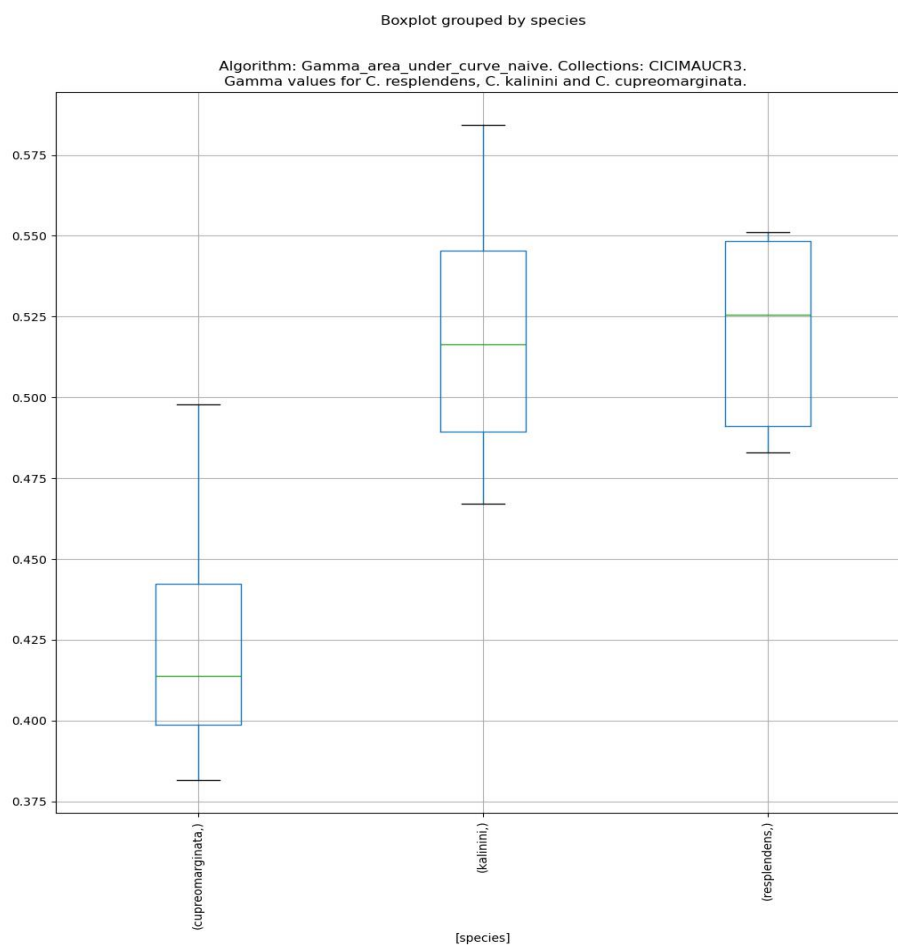


## Algorithm description: Gamma\_area\_under\_curve\_naive

This method calculates the ratio between the area under the curve for the spectrum between 450 and 800 nm (visible range) and between 800 nm and 1500 nm (Infrared range).

## Results

### Gamma boxplot for Gamma\_area\_under\_curve\_naive



***Differentiable species:***

Assuming each species is distributed normally: Differentiable species are: ['cupreomarginata']. 75.0% of these specimens will be found in a region in which the probability of being a specimen of other species is less than 25.0 %.

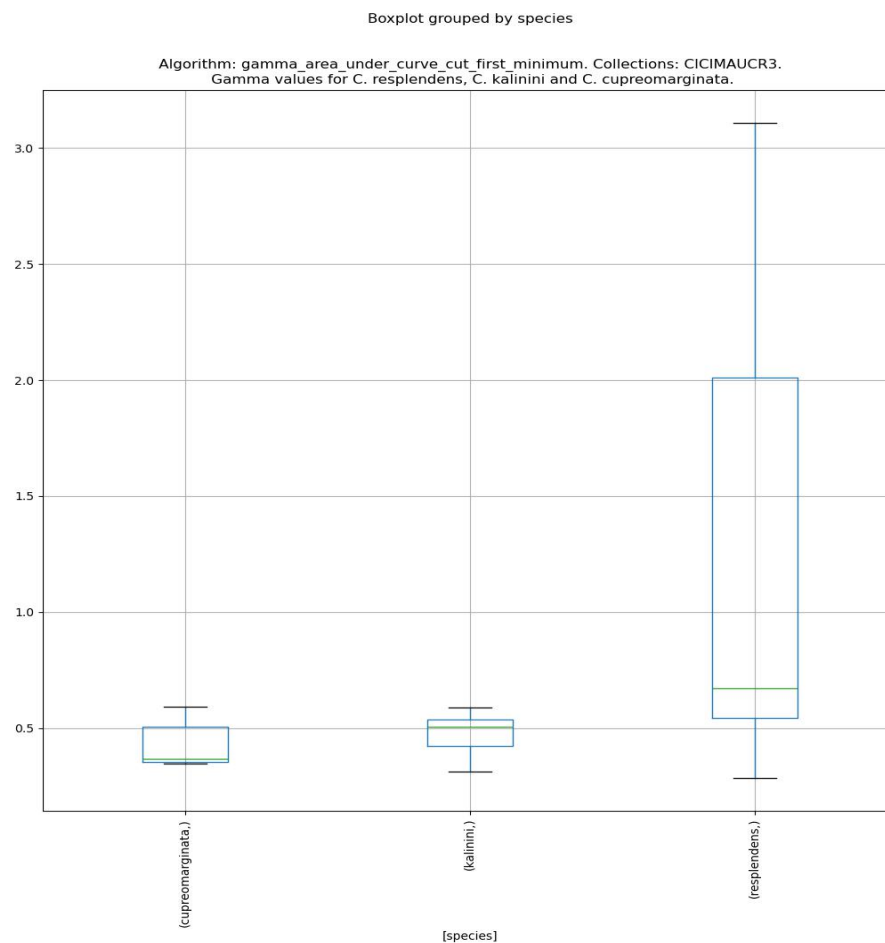
## Algorithm description:

### **gamma\_area\_under\_curve\_cut\_first\_minimum**

This algorithm calculates the area for the visible region (starting at 450 and ending in the first minima between the maximum in the visible range and the maximum in the IR range. Then calculates the area of the IR range up to the second minimum. The ratio between these two areas is the gamma value.

## Results

### ***Gamma boxplot for gamma\_area\_under\_curve\_cut\_first\_minimum***



***Differentiable species:***

Assuming each species is distributed normally: Differentiable species are: ['resplendens']. 75.0% of these specimens will be found in a region in which the probability of being a specimen of other species is less than 25.0 %.

## Similarity Index:

For each spectrum a similarity index is calculated which is the sum of the squared differences between the wavelength peak values of the unknown sample and the average wavelength peak values for each species.

### ***Test results:***

The reported(correct) species is compared with the species with the lowest similarity index (si), the final column (test\_result) shows if the species coincide:

### ***The amount of correct guesses is 12 out of 25***

The accuracy (Percentage of correct classifications out of total classifications) is 48.00 %

For kalinini, precision (correct classifications out of all classifications for this species) is 41.18 % and recall (out of the actual specimens for this species how many were correctly classified) is 87.50 %.

For resplendens, precision is 0.00 % and recall is 0.00 %.

For cupreomarginata, precision is 83.33 % and recall is 71.43 %.

code	species	kali_si	cupr_si	resp_si	prediction
CICIMAUCR0008	kalinini	50.471	90.324	67.675	kalinini
CICIMAUCR0070	resplendens	87.411	81.11	95.755	cupreomarginata
CICIMAUCR0019	cupreomarginata	89.111	79.081	97.955	cupreomarginata
CICIMAUCR0100	cupreomarginata	85.911	77.481	96.355	cupreomarginata
CICIMAUCR0009	kalinini	61.371	80.152	56.075	resplendens
CICIMAUCR0006	kalinini	67.511	92.624	91.555	kalinini
CICIMAUCR0098	cupreomarginata	76.271	69.724	66.675	resplendens
CICIMAUCR0158	cupreomarginata	88.711	80.281	99.155	cupreomarginata
CICIMAUCR0141	kalinini	64.211	92.652	88.955	kalinini
CICIMAUCR0013	resplendens	71.711	81.224	80.155	kalinini
CICIMAUCR0014	cupreomarginata	92.011	82.51	99.955	cupreomarginata
CICIMAUCR0101	resplendens	51.371	92.552	65.275	kalinini
CICIMAUCR0020	resplendens	64.811	85.252	79.555	kalinini
CICIMAUCR0001	kalinini	63.111	93.024	91.955	kalinini
CICIMAUCR0012	cupreomarginata	76.511	87.224	86.155	kalinini
CICIMAUCR0112	resplendens	68.611	83.052	79.755	kalinini
CICIMAUCR0104	resplendens	136.481	222.652	197.505	kalinini
CICIMAUCR0116	kalinini	68.211	87.452	83.355	kalinini

CICIMAUCR0021	resplendens	69.211	82.852	80.355	kalinini
CICIMAUCR0113	kalinini	57.371	87.352	59.275	kalinini
CICIMAUCR0015	resplendens	67.211	84.052	81.155	kalinini
CICIMAUCR0097	kalinini	73.611	88.052	78.655	kalinini
CICIMAUCR0071	resplendens	133.781	225.024	204.905	kalinini
CICIMAUCR0018	cupreomarginata	88.711	78.281	97.155	cupreomarginata
CICIMAUCR0108	resplendens	73.211	80.452	80.355	kalinini

## Peak\_Ratio\_And\_Wavelength\_Similarity\_Index:

This algorithm calculates the square difference for wavelength and the square difference in gamma values and multiplies them. Lower values are for spectra that has similar wavelengths and similar gamma values with respect to known spectra

Test results:

The reported(correct) species is compared with the species with the lowest similarity index (si), the final column (test\_result) shows if the species coincide:

### ***The amount of correct guesses is 21 out of 25***

The accuracy (Percentage of correct classifications out of total classifications) is 84.00 %

For kalinini, precision (correct classifications out of all classifications for this species) is 88.89 % and recall (out of the actual specimens for this species how many were correctly classified) is 100.00 %.

For resplendens, precision is 87.50 % and recall is 70.00 %.

For cupreomarginata, precision is 75.00 % and recall is 85.71 %.

code	species	cupreomarginata	kalinini	resplendens	prediction
CICIMAUCR0008	kalinini	5.097	0.085	6.216	kalinini
CICIMAUCR0070	resplendens	9.745	0.27	16.515	kalinini
CICIMAUCR0019	cupreomarginata	0.011	6.104	0.212	cupreomarginata
CICIMAUCR0100	cupreomarginata	0.004	5.159	0.418	cupreomarginata
CICIMAUCR0009	kalinini	1.931	0.796	2.673	kalinini
CICIMAUCR0006	kalinini	28.136	3.778	35.849	kalinini
CICIMAUCR0098	cupreomarginata	0.145	6.484	0.009	resplendens
CICIMAUCR0158	cupreomarginata	0.0	5.51	0.369	cupreomarginata
CICIMAUCR0141	kalinini	3.785	0.336	6.323	kalinini
CICIMAUCR0013	resplendens	3.638	13.794	2.03	resplendens
CICIMAUCR0014	cupreomarginata	0.252	3.766	1.335	cupreomarginata
CICIMAUCR0101	resplendens	0.808	5.73	0.092	resplendens
CICIMAUCR0020	resplendens	0.039	4.732	0.107	cupreomarginata
CICIMAUCR0001	kalinini	7.633	0.0	11.483	kalinini
CICIMAUCR0012	cupreomarginata	0.012	4.435	0.433	cupreomarginata
CICIMAUCR0112	resplendens	0.221	6.048	0.003	resplendens
CICIMAUCR0104	resplendens	0.835	12.734	0.004	resplendens
CICIMAUCR0116	kalinini	10.374	0.196	14.22	kalinini
CICIMAUCR0021	resplendens	0.083	5.399	0.055	resplendens

CICIMAUCR0113	kalinini	4.909	0.098	5.427	kalinini
CICIMAUCR0015	resplendens	3.475	12.5	1.84	resplendens
CICIMAUCR0097	kalinini	5.819	0.041	8.214	kalinini
CICIMAUCR0071	resplendens	0.264	6.532	1.805	cupreomarginata
CICIMAUCR0018	cupreomarginata	0.029	6.384	0.147	cupreomarginata
CICIMAUCR0108	resplendens	6.149	18.008	4.098	resplendens



## References

1. Author A, et al. (Year). Title of the paper. Journal Name, Volume(Issue), Page Numbers.
2. Author B, et al. (Year). Title of the paper. Journal Name, Volume(Issue), Page Numbers.